TECHNOLOGY REVIEW

June 1959

V.61 #8

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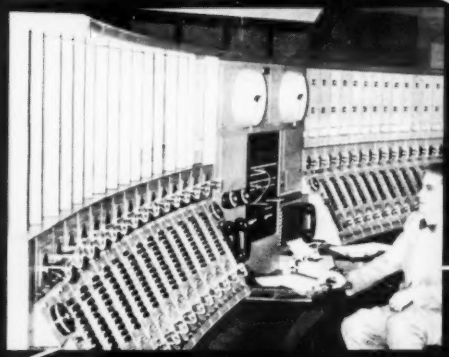
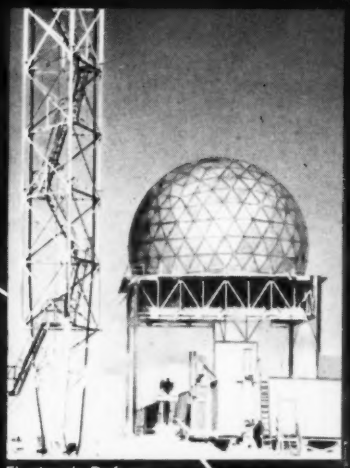
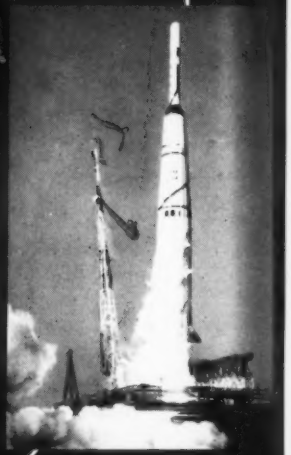




Electronic Defense

Electronic Guidance



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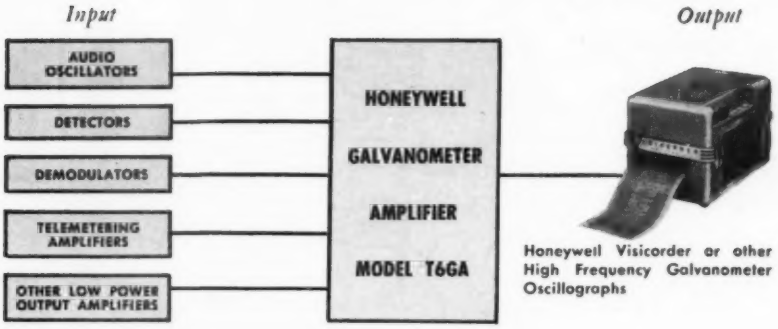
NEW GALVANOMETER AMPLIFIER

Strengthens Low Power Signals to Drive High Frequency Oscillographs



Galvanometer Amplifier, Model T6GA-1, measures 3½" high, 19" wide, 15½" deep.

DESCRIPTIVE DATA

VOLTAGE GAIN:
Adjustable from 0 to 1.0

OUTPUT (37 OHM LOAD):
±2.4 volts at 65 ma d-c to 8 Kc, limits at ±100 ma.

OUTPUT IMPEDANCE:
2 Ohms d-c to 10 Kc

CONTROLS:
6 GAIN controls, 1 Power ON-OFF switch

INPUT IMPEDANCE: 47 K

ISOLATION:
Individually floating channels for use with ungrounded loads

NOISE:
Less than 3 mv peak-to-peak

DRIFT:
Less than 3 mv/°F

POWER REQUIREMENTS:
115 volts ±10 volts, 50 to 440 cps, 45 watts

With Honeywell's new Galvanometer Amplifier, Model T6GA-1, high frequency oscillographs can now be operated directly by low power input sources of 1 volt or more. These inputs, some of which are shown in the diagram above, should have output impedances of 10 K or less although higher source impedances can be tolerated. Noise and drift are indistinguishable on the recorded output when the galvanometer-amplifier combination has a maximum sensitivity of 1 inch per volt.

The Model T6GA-1 is a compact, six channel, three stage transistor d-c amplifier with overload protection to eliminate both danger of transistor damage and galvanometer burnout.

Each of the six amplifier channels is isolated from ground by individual floating power supplies. Write for Bulletin B-ET6 to Minneapolis-Honeywell, Boston Division, Dept. 1, 40 Life Street, Boston, Mass.

Honeywell

H HONEYWELL *First in Control*

THE TECHNOLOGY REVIEW, June, 1959, Vol. LXI, No. 8. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription, $4.00: Canadian and Foreign subscription, $4.50. Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879.

The contributions C. H. Wheeler's Reverse Flow makes in solving CONDENSER MAINTENANCE PROBLEMS

An informative advertisement from one of the nation's most experienced condenser manufacturers

Since a major condenser maintenance problem is caused by foreign matter, algae and scale which clog tubes and sheets, there is a constant search for better ways to remove this contamination. One of the most successful methods is Reverse Flow (see diagram on right), a system of back-flushing tubes and sheets without shutting down the condenser.

This Reverse Flow design, patented by C. H. Wheeler Manufacturing Company, designer and builder of steam condensers since 1903, has proved itself in installations throughout the world. Here's how it works:

Normal operation is shown on the left. Water enters through inlet A with inside port open, flows through tube bank C to the rear of the condenser. It returns through tube bank D to the front of the condenser and discharges at E.

The right side of the diagram above shows Reverse Flow in operation in a C. H. Wheeler Dual Bank, Divided Water Box Condenser. Water enters through A with outside port open, flows up through channel B and through tube bank D to rear of condenser, returns through tube bank C to front of condenser and discharges at E. Reversing can be accomplished during full load operation and full flow of circulating water, without additional pressure loss. Sluice gates for each half of the condenser move on a common stem. Each half of the condenser can be back-flushed independently; or both halves can be back-flushed simultaneously with one or two circulating pumps operating.

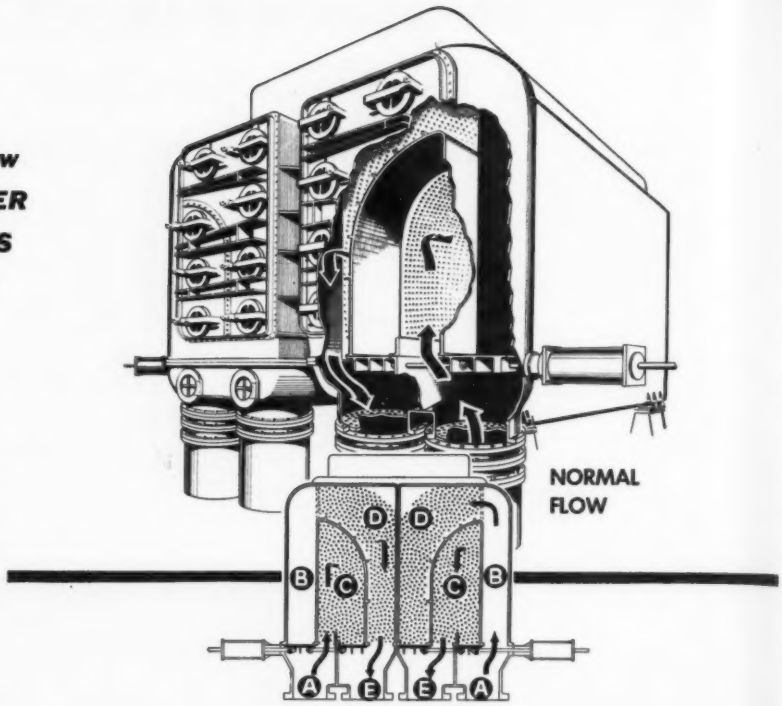


Fig. 1: Simplified diagram showing how Reverse Flow cleans tubes and sheets during full load operation.

Other Ways To Keep Tubes Clean

Special slugs are sometimes used to remove algae and foreign matter from the insides of condenser tubes. They're forced through the tubes by high-pressure water; thus scale and other contamination is flushed as it's dislodged. When the slugs are metal, care must be taken to prevent ruining them as they fly from the outlet side of the tubes.

Sometimes a 5% HCl solution is introduced into the tubes to dissolve the scale. While this method is effective, it is often necessary to leave the acid in the tubes for six hours or so—thus prolonging down time. Also, it's necessary to flush the tubes before the condenser can be put back in service.

In general, maintenance becomes more of a problem as water-source pollution increases; also as circulating water temperature rises, because the rate of scale formation increases at higher water temperatures.

Solving Deaeration Problems

Oxygen and other non-condensable vapors in the condensate result from leaks or are introduced through make-up water or heater returns. Most authorities believe that the greatest source of oxygen is make-up water.

Make-up water which is not properly heated in the condenser and agitated sufficiently to release entrained gases results in excessive oxygen and other non-condensables in the condensate. As a consequence, corrosive oxides may be deposited in the boiler, reducing its efficiency.

Proper distribution of normal make-up water is achieved in Wheeler condensers by spraying it over the top of the tube banks at both ends of the tubes, and out of the path of high-velocity steam from the turbine exhaust. Steel bars above tubes protect them from water impingement damage.

Heater returns are sprayed in the steam lanes to permit flashing and distribution of the returns and release of entrained gases.

All condensate draining off the tubes is cascaded over a series of horizontal deaerating bars (1, Fig. 3) in the presence of a moving blanket of steam to provide greater agitation and reheating before condensate is drained into the hotwell.

Fig. 2: A few of the types of slugs used to clean the inside of condenser tubes.

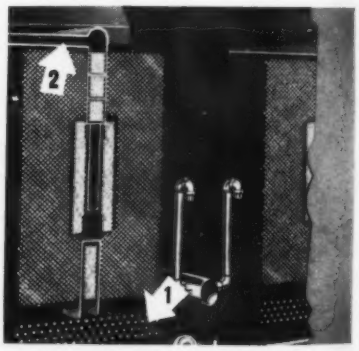


Fig. 3: Drawing of deaerating bars and air-vapor suction line. Tubejet® Air Ejector.

Notice too, location of the air-vapor suction line (2), through which the Tubejet® Ejector draws off non-condensable gases and discharges them to the atmosphere.

In C. H. Wheeler Dual Bank Divided Water Box Condensers the air cooler section is centrally located, so as to reduce depth of steam penetration and consequently resistance to steam passage, achieving a new low in pressure loss in the condenser.

If you have a maintenance problem that doesn't seem to improve no matter what you do, C. H. Wheeler may be able to help. Get in touch with a Wheeler representative or write direct. No obligation.

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"CREATIVE ENGINEERING" TURNS A TROUBLESOME WASTE INTO A VALUABLE FUEL

Waste carbon monoxide is sentenced to hard labor in the refinery

For years, refinery operators were concerned about the loss of a by-product with an untapped capacity to do work. Produced in volume by their catalyst regenerators, Btu-loaded carbon monoxide was being discharged to the atmosphere for want of a technique to burn it efficiently and productively.

The problem of burning this "lean," moist, toxic gas for the production of steam was not entirely new to Combustion, since the company had designed a large number of boilers to burn a similar fuel – blast furnace gas. Based on this experience, C-E engineers believed that *"tangential firing"** would be the most effective method of burning carbon monoxide. And so it proved to be. Working in close cooperation with refinery engineers, C-E specialists designed a tangentially-fired boiler which has fully demonstrated its ability to provide the intense turbulence and almost instantaneous combustion needed for the most efficient utilization of this waste product. Today, the C-E "CO" Boiler is providing extra dividends to the refinery industry in the form of steam for power and process.

Here then is another example of Creative Engineering–the C-E approach to providing the most advanced designs of boilers for all fuels and steam requirements–from those of small industrial and institutional plants to the largest utility power stations.

* An exclusive C-E development which has been outstandingly successful in burning pulverized coal, oil and gas in hundreds of installations. Involves firing from the four corners of a furnace to create a tornado of flame as illustrated.

"CREATIVE ENGINEERING" is the reason for the leadership attained by C-E products. The products which bear this mark of leadership include:

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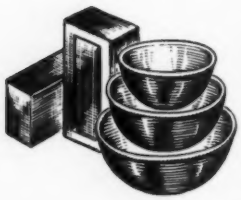
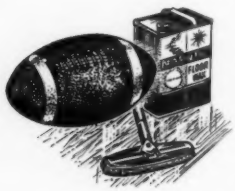


. . . bricks or bowls

. . . rubbers or rugs



. . . footballs or floor waxes

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The items above can only begin to hint at the enormous range of products which contain a pinch or a pound of one Cabot raw material or another.

Put it this way: no matter where you are as you read this, chances are excellent that you are within reaching distance of at least one.

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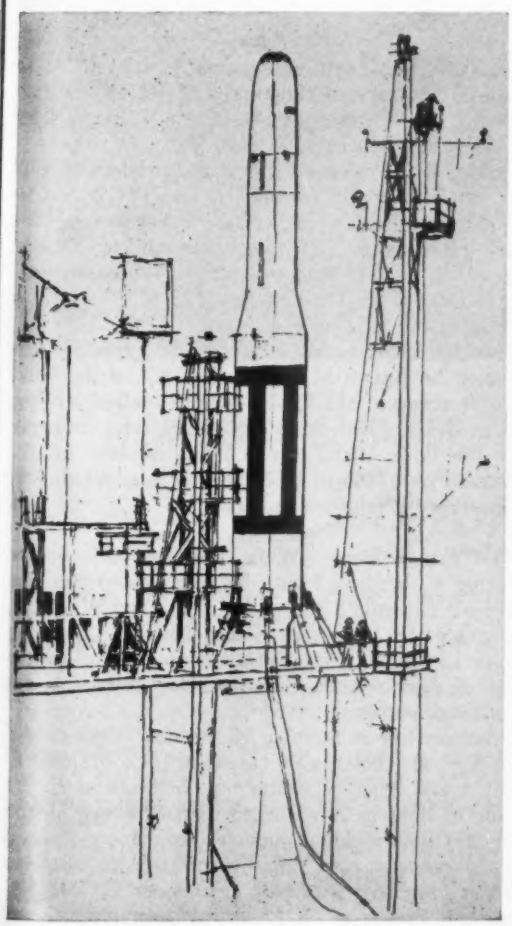
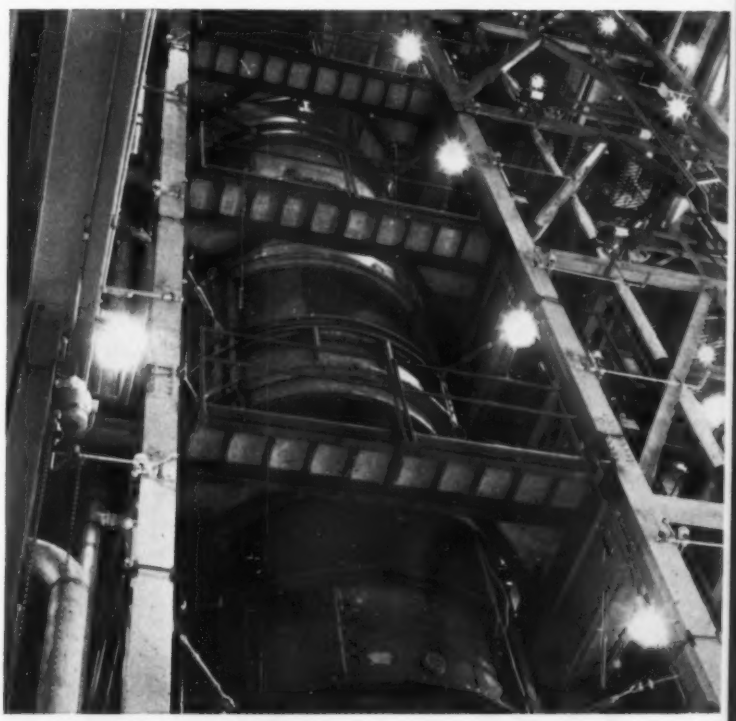
ONE IMPORTANT REASON WHY THERE CAN BE A BLASTOFF

The dome head you see at the right is part of what are familiarly known among the missiles people as "battleship tanks." That's because it is too heavy to be air borne. Yet it performs an important function in the missiles program. It is a part of heavy-walled units like those below which are used to test components, subsystems and systems for the TITAN missile by The Martin Company at its Denver facility. Graver's assignment was a number of dome heads and cones for this testing installation, another example of how Graver's century-proved skills with alloys and special steels are being employed in the missiles program.





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THE PHOTOGRAPHERS

The Cover. – GJON MILI, '27, made the photograph of Professor Gordon S. Brown, '31, that is on the cover of The Review this month. He did this while working on a photographic essay for *Life* magazine. Mr. Mili made many excellent pictures of members of the Faculty and students at that time, some of which were exhibited last year in the Hayden Memorial Library. The Review plans to publish more of them.

Photo by George W. Brown, '58

Gjon Mili, '27

Mr. Mili was born in Albania and grew up in Romania. He came to the United States to study engineering in 1923, scarcely able to speak English, but quickly gained Professor Norbert Wiener's respect by the speed with which he solved a third-degree equation. While working for the Westinghouse Electric Company, he became increasingly interested in high-speed photography. He has worked closely with Professor Harold E. Edgerton, '27, who considers him "the leading journalist photographer in the world in the use of the stroboscope."

This and other recent covers of The Review were designed by RALPH M. H. COBURN, '47, of the Office of Publications at M.I.T. Mr. Coburn studied architecture at the Institute from 1942-1945, was graduated from the Boris Mirski Art School, and later studied in Paris. From 1945 to 1955, he was assistant director of the Boris Mirski Art Gallery.

The Frontispiece. – While Professor Wiener was covering a blackboard with his solutions to nonlinear problems in random theory last year, YUK-WING LEE, '27, Associate Professor of Electrical Engineering, snapped some 400 pictures for the record. An enlargement of one of those documentary photos is this month's frontispiece.

Professor Lee (a member of the same class as Mili) has been an enthusiastic amateur photographer for many years. Since receiving his doctorate at the Institute in 1930, he has worked with Professor Wiener both in China and this country. From his pictures of the blackboard, and tape recordings of Professor Wiener's remarks, Professor Lee, Amar G. Bose, '51, Assistant Professor of Electrical Engineering, and others prepared a manuscript for Professor Wiener to edit and The Technology Press to publish.

New space-scanning radio telescope equipped with *Styroflex® Coaxial Cable*

Styroflex® coaxial cable is an important component part of the new radio telescope now in operation at the National Radio Astronomy Observatory, Green Bank, W. Va. This remarkable telescope is designed to probe the universe for radio waves originating in space.

Six "runs" of Styroflex® coaxial cable connect the 85-foot parabolic antenna with the control building. These "runs" are used to relay radio waves picked up from outer space by the telescope.

The job of feeding these low-energy radio waves to the control center calls for a high frequency cable with a low inherent noise level. The low loss and low noise to high signal ratio of Styroflex® cable provide the ideal answer to these operational requirements. An additional advantage is the long operating life of this coaxial cable, regardless of climatic conditions.

The superior properties of Styroflex® cable have earned for it an outstanding reputation in high frequency cable applications of many different kinds. If you have a problem requiring the use of a high frequency cable with exceptional characteristics, perhaps Styroflex® can provide the answer.

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How NRC High Vacuum Technology Can Help You Conquer Extreme Altitudes

Under the high vacuum conditions encountered in outer space, familiar products and processes which work at sea level may develop strange and unfamiliar characteristics.

For example, at extreme altitudes metal-to-metal contact may cause parts to gall or stick. Graphite lubricants lose their effectiveness. Grease vaporizes rapidly. Plastics change their properties. Some metals such as zinc evaporate directly. Rocket flame patterns change and fuels behave differently.

COSTLY FAILURES AVOIDED — A superior method of making sure your product or component will work in outer space is to test it in simulated high vacuum conditions encountered at altitudes from 200 to 600 miles. A missile failure can cost over $2,000,000 and all traces of the cause can be lost with it. National Research Corporation can help you predict your product performance in several ways.

Data relating to your product or materials may already be on hand. Much information has been generated in connection with the development of high vacuum processes and equipment over the past 20 years.

Existing facilities are available in our laboratories for doing basic materials research for outer space and missile applications on a contract basis.

Together with our subsidiary, NRC Equipment Corporation, we can deliver a turn key installation which will simulate high vacuum conditions above 100 miles. If you wish to assemble your own high vacuum facilities, standard gauges, valves, pumps and accessories are in stock for immediate shipment. The services of our field engineers will help you save time, money and trouble.

Call or Write in today for preliminary exploration of how we can help you build products or select materials for outer space components.

Chart prepared by National Research to indicate vacuum requirements for space simulation. Data taken from International Geophysical Year Reports. Copyright 1958 by National Research Corp.

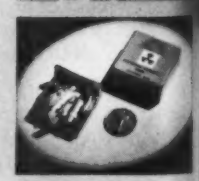
Almost weightless heat reflective or corrosion resistant metallic coatings from 2 millionths to 2 thousandths thick can be deposited on metals, plastics, fabrics, or paper. NRC can develop the coatings or supply the equipment.

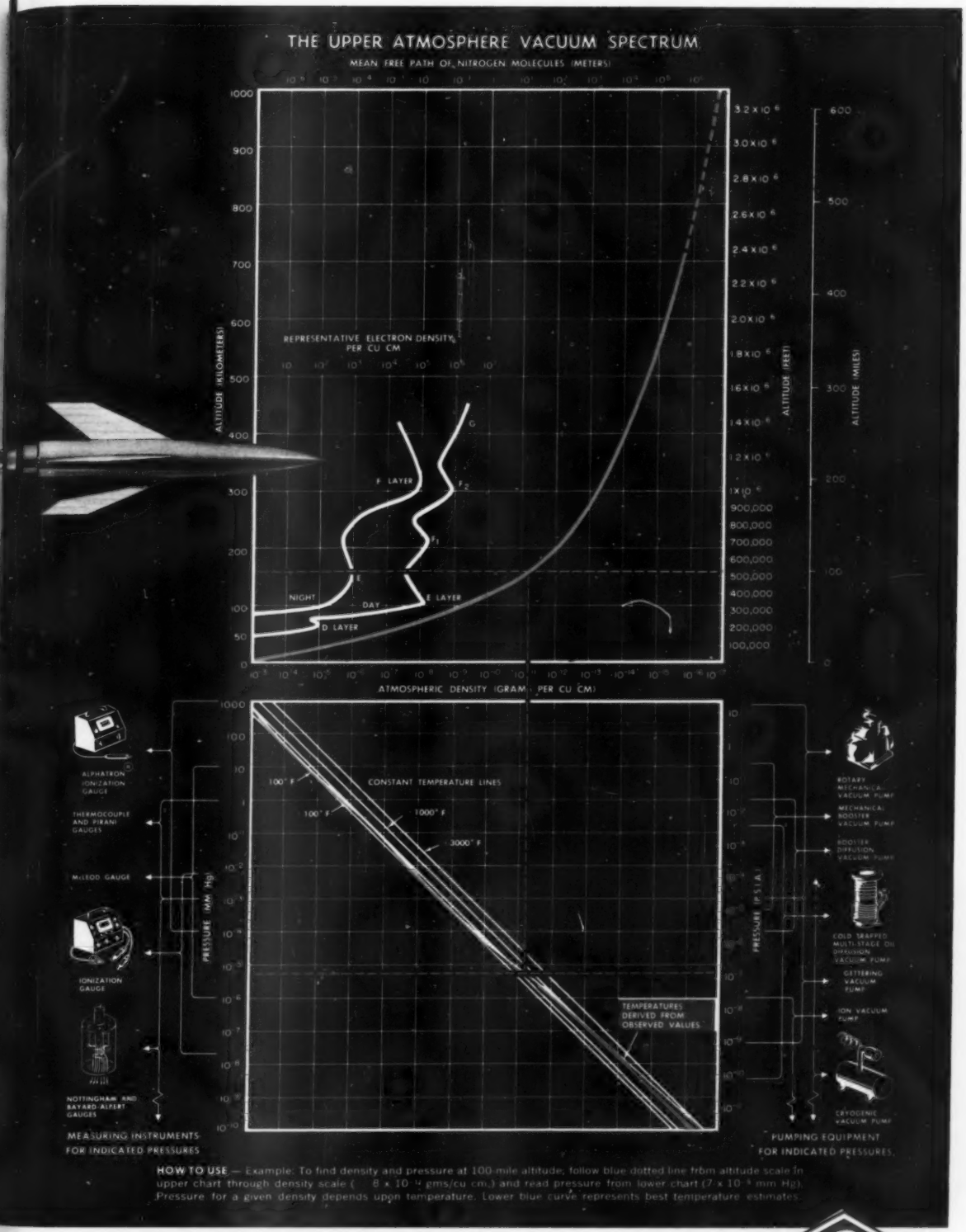
A complete line of vacuum arc, induction and resistance furnaces is available to help you develop or produce new high performance metals. Services of our vacuum metallurgical department are available.

Know gas content in metals with the NRC Gas Analyzer. Hydrogen, oxygen and other gases in metals can cause fatigue or product failure under high temperatures.

Comprehensive information through NRC test facilities is available on effects of low pressures on flexibility, outgassing, slip, chemical stability, etc., of metallic refractories and plastics.

For measuring density at high altitudes the 2-ounce Alphatron® densitometer can be connected directly to telemetering equipment.





HOW TO USE — Example: To find density and pressure at 100-mile altitude, follow blue dotted line from altitude scale in upper chart through density scale (8 x 10^{-14} gms/cu cm.) and read pressure from lower chart (7 x 10^{-9} mm Hg). Pressure for a given density depends upon temperature. Lower blue curve represents best temperature estimates.

FREE—Copy of new brochure "HIGH VACUUM TECHNOLOGY AND THE SPACE AGE" which contains a large 3-color version of above chart. Write on your firm letterhead.

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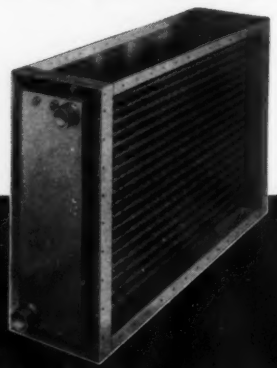

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25 YEARS AGO

■ On June 5, 1934, at commencement exercises held at Symphony Hall to mark the graduation of the Institute's 67th Class, President Karl T. Compton formally created 460 new bachelors and 152 masters of science; 21 new bachelors in architecture; and 15 and 11 new doctors of philosophy and science, respectively. Deducting for those receiving two degrees yielded 639 as the total number in the 1934 graduating group.

As Chief Marshal, Alexander Macomber, '07, who five years earlier had been the Alumni Association's 35th President, led the academic procession which included, besides members of the Corporation and Faculty, 21 of the 50-year Class of 1884, and the following distinguished guests: Joseph B. Ely, Governor of the Commonwealth; Redfield Proctor, '02, the 40th President of the Alumni Association; and Howard Blakeslee, Science Editor of The Associated Press, who gave the commencement address.

Finally, came the long procession of degree candidates led by Richard Bell, President of the Class of 1934, and its three elected marshals: Henry D. Humphreys, G. Kingman Crosby, and Edgar B. Chiswell, Jr.

■ Also on June 5, 1934, the Corporation elected *Horace S. Ford,* Bursar of the Institute since 1914, as Treasurer to succeed the late *Everett Morss, '85; Delbert L. Rhind,* Assistant Bursar since 1921, to succeed Mr. Ford as Bursar; and *Wolcott A. Hokanson,* a member of the Bursar's staff since 1915, to succeed Mr. Rhind as Assistant Bursar.

■ Congratulations were being extended to *Frank W. Lovejoy, '94,* as President of the Eastman Kodak Company; . . . to *John R. Macomber, '97,* as Chairman of the newly formed First of Boston Corporation; . . . to *Marshall B. Dalton, '15,* as President of the Boston Manufacturers Mutual Fire Insurance Company; . . . and to *John W. Barriger, 3d, '21,* as Chief Examiner of the Railroad Division of the R.F.C.

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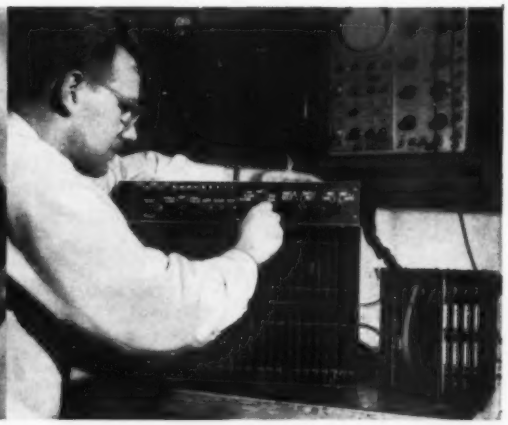

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Career opportunities... Sperry Gyroscope stands for steady growth. For almost a half century, we've been expanding—and our engineers have grown with us. We offer something more than a job, to the right man. We offer a career, and a rewarding future.

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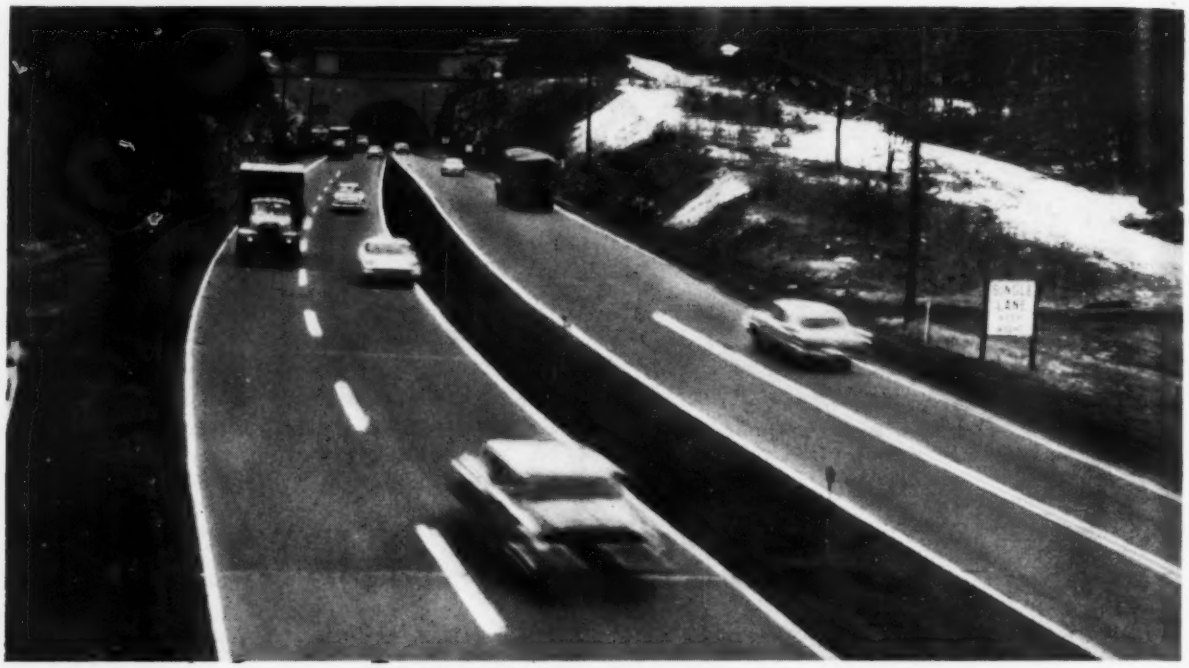
The World's First Turnpike-Proved Tires!



Pennsylvania Turnpike photo, above, was taken at the western end of the 1¼ mile Sideling Hill Tunnel—longest tunnel on the Turnpike.

This year you'll be driving more than ever before on throughways, expressways and turnpikes—at high legal speeds. For greater safety, you need Turnpike-Proved Tires by Goodyear.

NEW RUBBERS!
NEW CHEMICALS!
NEW CORDS!

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But first, Goodyear scientists had to solve two vital problems:

Problem #1—tread rubber: At high speeds, ordinary tread rubber is literally eaten away. But by *intimate mixing* of new chemicals and rubber molecules, Goodyear scientists created today's longest-wearing tread rubber for today's toughest driving conditions.

Problem #2—tire cord: At high speeds, heat also weakens cord. The answer? Goodyear's 3-T *triple-tempered* cord (Tyrex or nylon) with strength and heat resistance other cords do not have.

Proved on "The Turnpike That Never Ends." On Goodyear's 140-mph test track at San Angelo, Texas, these tires *proved* they'll give you more safe mileage than any other tires.

See them at your Goodyear dealer's. Goodyear, Akron 16, Ohio.

GOODYEAR

MORE PEOPLE RIDE ON GOODYEAR TIRES THAN ON ANY OTHER KIND!

Watch "Goodyear Theater" on TV every other Monday evening.

The Technology Review

REG. U.S. PAT. OFF.

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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TALK OF OUR TIMES — 418

Mrs. Philip P. Kimball christened a new shell for the M.I.T. crew on May 2. It was named in memory of Philip P Kimball, '56, who died on a geophysical exploration trip in Brazil a year ago. He was the son of the Secretary of the Institute, and was a member of the championship lightweight crew that won at Henley in 9 5.

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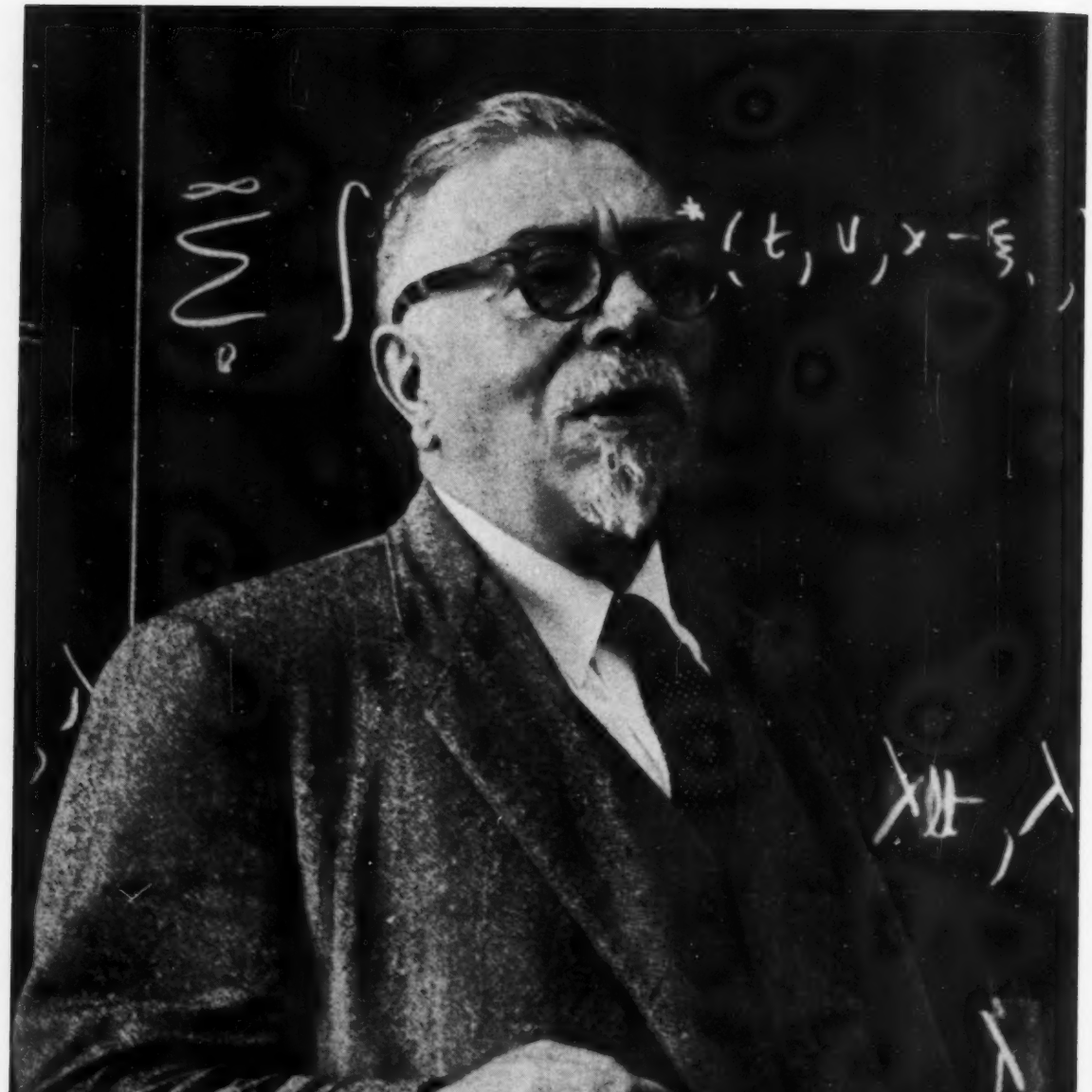
Three weeks must be allowed to effect change of address, for which both old and new addresses should be given.



Institute Professor Wiener

The Technology Review

VOL. 61, NO. 8 JUNE, 1959

The Trend of Affairs

Faculty Promotions Announced by M.I.T.'s New President

■ On Monday, June 15, Julius A. Stratton, '23, will be inaugurated as the 11th President of the Massachusetts Institute of Technology. Many of the Alumni and friends of the Institute who will assemble then to honor President Stratton also will wish to congratulate:

Gordon S. Brown, '31, who will become Dean of the School of Engineering on July 1, after heading the Institute's largest department for seven years;

C. Richard Soderberg, '20, because of his achievements as Dean of the School of Engineering since 1954 and his appointment as an Institute Professor;

Norbert Wiener, another newly appointed Institute Professor, who continues to astonish his colleagues by his scientific and literary productivity at the age of 64;

Seventeen others who were promoted to the rank of professor, 27 who became associate professors, and 15 who became assistant professors this spring.

These promotions, and 18 new appointments, were reported to the Faculty in May by President Stratton.

The New Dean of Engineering

■ Professor Gordon S. Brown, '31, who was named by the Executive Committee of the Corporation to succeed Dean Soderberg of the School of Engineering, has been a member of the Institute's teaching staff since 1931. As an authority on automatic control systems, he has won international renown, and as head of the Department of Electrical Engineering he has directed a revolutionary revision of its curriculum.

Professor Brown (who is pictured on the cover of this issue of The Review) was the first director of the M.I.T. Servomechanisms Laboratory, which has concentrated on the development of electric and hydraulic servomechanisms and efforts to increase basic knowledge of them. This was the only laboratory of its kind in an American university when World War II began and it undertook an extensive program for the armed services. In recognition of its work under Professor Brown's direction, he received in 1948, the nation's highest civilian award, the President's Certificate of Merit. He also received the Naval Ordnance Development Award. Since then the Servomechanisms Laboratory has influenced the educational programs of many other institutions.

Institute Professor Soderberg

Born in Australia, Professor Brown studied at the Melbourne Technical School and worked as a junior engineer before coming to the United States in 1929, at the age of 22. Since enrolling then as a student, he has been continuously associated with the Institute. He became an instructor in 1932 and received his doctorate at M.I.T. in 1938. He often has been a consultant on governmental and industrial problems and has written numerous technical papers and articles on engineering education. He is a Fellow of the American

Academy of Arts and Sciences, the American Institute of Electrical Engineers, and the Institute of Radio Engineers.

"When the whole field of electrical engineering was in a state of great change and development," President Stratton pointed out in his announcement of Professor Brown's appointment as Dean, "he accepted the challenge of revitalizing our instruction and research activities in this field. I am fully confident that he will provide for the whole School of Engineering the same kind of constructive, imaginative leadership which has made the Department of Electrical Engineering the most outstanding of its kind in the country."

Institute Professor Soderberg

■ Few men become Institute Professors, posts created to recognize outstanding achievement and breadth of interest. These posts free men from the limitations of departmental duties. As an Institute Professor, Dean C. Richard Soderberg, '20, will realize his wish to be relieved of administrative work and enabled to devote his efforts wholly to teaching and writing.

Born in Sweden, Dean Soderberg came to the United States and to M.I.T. in 1919 as a Fellow of the American Scandinavian Foundation. After graduation, he was chief engineer of the Turbine Division of the Westinghouse Electric Corporation. His teaching, his leadership as an educator, and his insight into the evolving needs of his profession, have been based on long and close associations with industry, both in this country and abroad; and his articles, on dynamics, vibrations, and the design of turbines and generators, have appeared in both American and European journals.

The Army, the Navy, and the Air Force have honored him for his services to this country, and last year he received the Royal Order of the North Star from Sweden's King Gustav VI. He has honorary degrees from both Chalmers Institute of Technology and Tufts University, and is a member not only of the National Academy of Sciences in this country but also of the Swedish Academy of Engineering Sciences.

Dean Soderberg joined the Institute's Faculty in 1938 as professor in the Department of Mechanical Engineering, became head of that Department in 1947, and was made dean of the School of Engineering in 1954. "His new appointment as Institute Professor," President Stratton said in announcing it, "will open to him still another role in a career of outstanding service to the Institute."

Institute Professor Wiener

■ For decades the academic world has showered its degrees and honors on Norbert Wiener but few have meant as much to him as his appointment to an Institute Professorship – a post for which, President Stratton commented, he is "undeniably" qualified.

Professor Wiener became an instructor in mathematics at M.I.T. 40 years ago – after receiving his Ph.D. from Harvard at the age of 18, studying abroad, teaching elsewhere, and having a fling at Boston newspaper work. No other gentleman of the press has become such a productive mathematician, won a comparable place in the affections of students and colleagues, or tried so hard in vain to prevent the world's press from beating a path to his door. The very week that his new appointment was headlined in this country, the Russian press was shattering precedent by publishing an apology for its previous failure to appreciate his scientific work, and book reviewers were asking Random House for galley proofs of his first novel, *The Tempter*.

Most widely known as the founder of cybernetics and a scholar interested in *The Human Use of Human Beings*, Professor Wiener is likely to be found nowadays participating in a seminar on almost any learned topic in whatever language you prefer, when not discussing international affairs, the arts, or bridge hands with his friends, or reflecting on such problems as those confronted in the analysis of brain waves.

With tape recordings of his lectures, supplemented by hundreds of photographs of his blackboards, his admirers helped him produce and prepare for publication last year the first work in English on *Nonlinear Problems in Random Theory*. He has continued such lectures this spring. Publishers are awaiting impatiently the manuscripts of more of his mathematical papers. Casting directors will also find his suggestions appropriate, and probably surprising, when the time comes to adapt his novel for presentation on the screen.

The Inauguration on Alumni Day

■ Members of the Corporation, Faculty, Alumni, students, and their guests will be assembled, and the Boston Symphony Orchestra will play, when Julius A. Stratton, '23, accompanies an academic procession into the Great Court at 11:00 A.M. on Monday, June 15, to be inaugurated as the 11th President of M.I.T.

The Chairman of the Corporation, James R. Killian, Jr., '26, who was succeeded as President by Dr. Stratton last January 1, will conduct the investiture ceremony. Luncheon will be served in tents on the lawn afterwards, and the speakers then will include: Nathan M. Pusey, President of Harvard University; Lee A. DuBridge, President of the California Institute of Technology; Charles Odegaard, President of the University of Washington (which the new President attended for one year); and Claude Seippel, Vice-president of the Board of Swiss Federal Institute of Technology in Zurich (where the new President received his doctor of science degree).

Arrangements for the occasion have been made by a committee headed by E. P. Brooks, '17, Dean of the School of Industrial Management. It includes B. Alden Thresher, '20, William L. Taggart, Jr., '27, Gilbert M. Roddy, '31, Robert M. Kimball, '33, Donald P. Severance, '38, Philip A. Stoddard, '40, Gerard J. Stephenson, Jr., '59, President of the Undergraduate Association, and Professor Albert Bush-Brown.

At commencement exercises the preceding Friday, June 12, John Cowles, President of the Minneapolis Star and Tribune Company, will speak.

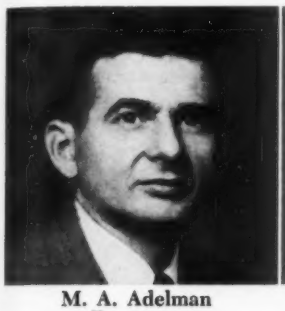
A summary of class reunions to be held in June, just preceding or following Alumni Day, is presented on page 436 of this issue of The Review.

Professors Now

■ During the academic year now drawing to a close, there were 209 professors, 171 associate professors, and 211 assistant professors on the Faculty of M.I.T. Fifty-nine promotions were announced in May. The 17 men who are pictured here were promoted to the rank of full professors; 27 others became associate professors, and 15 became assistant professors.

Eighteen new appointments were announced at the same time. These included two Alumni, Stephen J. Kline, '52, and H. Philip Whitaker, '44, who became associate professors, and three Alumni, James C. Emery, '54, Cary J. King, '58, and James L. Stockard, '52, who became assistant professors. The new appointments to professorships are reported on page 430.

M. A. Abkowitz, '40
Naval Architecture



M. A. Adelman
Economics

R. B. Adler, '43
Electrical Engineering

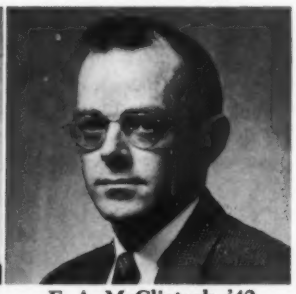
N. C. Dahl, '52
Mechanical Engineering

S. A. Goldblith, '40
Food Technology

D. N. Hume
Chemistry

H. W. Johnson
Industrial Management

T. W. Lambe
Civil Engineering



F. A. McClintock, '42
Mechanical Engineering

S. J. Mason, '47
Electrical Engineering

P. Pigors
Economics

B. G. Rightmire, '41
Mechanical Engineering

L. Rodwin
City Planning

L. B. Rogers
Chemistry

C. N. Satterfield, '43
Chemical Engineering

I. M. Singer
Mathematics

P. D. Wall
Biology

The Alumni Association's Officers

■ The M.I.T. Alumni Association elected, in the balloting which ended April 25: Edward J. Hanley, '24, as its President for one year; William L. Taggart, Jr., '27, as Vice-president for two years; and Henry B. Backenstoss, '34, and Albert O. Wilson, Jr., '38, as members of the Executive Committee for two years.

The Association named as nominees, for five-year alumni term membership on the M.I.T. Corporation, William Webster, '23, John J. Wilson, '29, and James B. Fisk, '31.

To serve on the National Nominating Committee for three years, it elected: Charles B. Stuart, '34 (for District 8); William R. Wheeler, '25 (for District 9); and Jacob A. Samuelson, '40 (for District 10).

Class representatives elected to the Alumni Council for five years were: Andrew D. Fuller, '95, Elbert G. Allen, '00, Robert W. McLean, '05, Herbert S. Cleverdon, '10, Azel W. Mack, '15, Edwin D. Ryer, '20, F. Leroy Foster, '25, George P. Wadsworth, '30, John D. Hossfeld, '35, John L. Danforth, '40, William J. McKay, '45, John T. Weaver, '50, and C. Harry Schreiber, Jr., '55.

Results of the balloting were reported to the Alumni Council at its 338th meeting on April 27 at the M.I.T. Faculty Club. At the same meeting, the Executive Committee nominated and the Council elected committee members as follows:

Alumni Fund Board – George P. Wadsworth, '30, as consultant to the Fund Board.

Alumni Day – Philip H. Peters, '37, and Albert O. Wilson, Jr., '38.

Audit and Budget – Dwight C. Arnold, '27, for three years.

Class Reunions – William F. Wingard, '39, for six years.

Honorary Members – Gardner S. Gould, '07, for five years.

Midwinter Programs – William L. Taggart, Jr., '27, and Henry B. Backenstoss, '34.

Nominations for Departmental Visiting Committees – Karl L. Wildes, '22, and Russell L. Haden, Jr., '40, for three years.

Nominations for Alumni Council Representatives of M.I.T. Clubs – John L. Danforth, '40, and Robert H. Bliss, '48, for three years.

Personnel – Ralph H. Davis, '31, for one year; Robert E. Anslow, '54, for two years; and Robert A. Bittenbender, '40, for three years.

Our Neighbors, Near and Far

■ The M.I.T. Alumni Council, at its April meeting, heard about the earth's neighbors and the modern city's neighbors. Herbert G. Weiss, '40, of Lincoln Laboratory, described the way his group had examined every part of a radar system and found ways to create a reaction 28,000,000 miles away on Venus, and Robert C. Wood, Assistant Professor of Political Science, described the immediate, personal problems of government in "the land of the station wagon and the septic tank" where one-fourth of America now lives.

Mr. Weiss called the establishment of radar contact with another planet "a community experiment" because it involved several disciplines. Radar's range was extended to a new frontier by the techniques developed, and radar now can be used as a tool to "tie down" the measurements of interplanetary distances.

Professor Wood emphasized the tendency of people to cluster in occupational, economic, and other groups as they migrate to satellite communities, and pictured vividly the few functions left to the central cities, the costly gray belts left between them and suburbia, and the difficulties of our thousands of small, independent political units.

Attendance at this meeting was unusually large – 158 members and guests were present – and a lively question period followed the two talks.

This year's Alumni Fund totaled $488,000 in April, Avery H. Stanton, '25, reported to the Alumni Council. This is $43,000, or 36 per cent, more than the final figure last year.

George Owen: 1871-1959

■ George Owen, '94, Professor of Naval Architecture, Emeritus, died on April 21 in Newton Center, Mass. Well known in the yachting world as a ship designer and racer, he taught in the Institute's Department of Naval Architecture and Marine Engineering from 1915 to 1941.

A native of Cambridge, Professor Owen was associated for a short time with the Herreshoff Manufacturing Company in Rhode Island, famous builder of yachts, and in 1907 began an independent career in shipbuilding and designing. By 1915, when he joined the Institute Faculty, he had designed and raced several championship yachts. He also designed the *Atlantis*, the research ketch of the Woods Hole Oceanographic Institution. Professor Owen's dinghies were introduced by the M.I.T. Nautical Association and are now widely used for collegiate racing. In appreciation of his enthusiastic support, the M.I.T. Nautical Association established the George Owen Trophy.

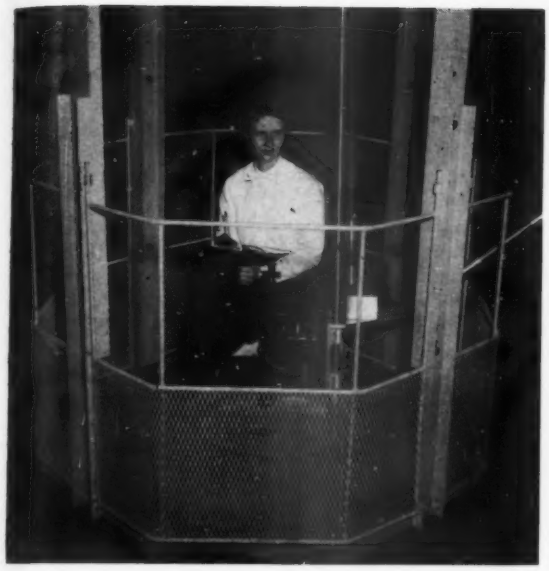
Professor Owen is survived by two children, George, Jr., of Milton, and Mrs. Florence O. Preble of Addison, Maine.

R. Colin Maclaurin: 1914-1959

■ R. Colin Maclaurin, son of the 6th President of M.I.T., died at the Massachusetts General Hospital on May 4. He had been a member of the administrative staff of the Institute for the last 13 years.

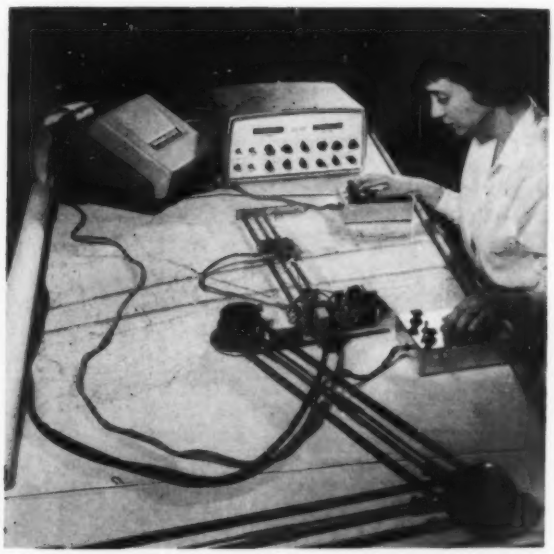
Mr. Maclaurin received the bachelor of science degree from Harvard University in 1938, served as safety engineer for the Bethlehem Steel Company at the Fore River Shipyard for two years, and in 1940 became an engineer for the J. P. Squire Company. He joined the Institute staff as Personnel Officer in 1946 after three years' service in the United States Navy. In 1954, he became director of General Services and served in that post until he was appointed assistant to the chancellor in 1958.

He is survived by his wife, Ellen Rhodes Maclaurin, and four children, Sheila, Peter Jerome, Richard Neil, and Colin, and by his brother, W. Rupert Maclaurin, Professor of Economics.



A Test for Guidance Apparatus

■ The inertial guidance system chosen for the Titan intercontinental ballistic missile was developed in the M.I.T. Instrumentation Laboratory, and will be produced by the AC Spark Plug Division of General Motors. The photos above, released when this was announced, show how the system was tested on the 18-ton centrifuge in the laboratory's Special Testing Facility at Hanscom Field in Bedford, Mass. Seated above the centrifuge hub is Agneta M. Mueller, daughter of Hans Mueller, Professor of Physics. Part of her job is to stay there and measure distortion of the centrifuge arm while it whirls at high speeds. Guidance equipment placed in the capsule (which you see behind her, and closeup in the photo at the right) on the tip of the arm is subjected to stresses and strains such as it must endure when it is used in a rocket.



A Post Office Is Studied

■ An aluminum scale model of a shell roof for a new post office in Providence, R.I., caught many visitors' eyes as it underwent stress analysis in the M.I.T. Civil Engineering Models Laboratory, under the supervision of Professors Hansen, Holley, and Biggs. Earlier, successive design studies for the structure were made on a series of plastic models.

A New Aid to Highway Engineering

■ As part of efforts to improve highway engineering with digital computers, E. Phillip Gladding, '57, teaching assistant in Civil Engineering at M.I.T., has designed the Digital Train Data Recorder shown above. With it, cross-section data in numerical form suitable for digital computations can be taken from a contour map about five times as fast as formerly.

(THE TREND OF AFFAIRS is continued on page 426)

M.I.T.'s New Language Laboratory

Optimum frequency requirements will be investigated with the recorders students now are using to perfect pronunciation

by JOSEPH R. APPLEGATE

The Linguatrainer installed at M.I.T. this spring was developed to increase the utility of tape-recording equipment for students of foreign languages. This account of the problem and the work now under way was written by the Assistant Professor of Modern Languages who is in charge of this new laboratory.

TRY to say *ich* not 'ish'." . . . "That word is *les* not 'lay'."

Such comments are frequently heard in elementary language classes, and the student's response often is: "But that's what I did say." He can hear no difference between his own pronunciation and that of his instructor.

If there is enough time for oral practice, the instructor can usually get the student to produce the phonetic patterns of the foreign language with some degree of accuracy. But each one of 20 students has only three minutes to speak in an hour-long class, if there is no other activity, and there are many other things to be done – syntax must be explained, assignments checked, corrections made, and so forth.

Language teachers have been concerned for years about how the student is to get oral practice. The mass production of record players offered some hope, but teachers soon realized that, although listening helped students to understand a spoken language, it did little to increase their fluency or to remove flaws in their pronunciation.

Then tape recorders seemed to be a solution. If each student had a tape recorder, he could hear a lesson, record his imitation of it, and compare his pronunciation with that of an instructor. Unless each student had two tape recorders, however, he had to erase the master recording in order to record his imitation. Of course, an entire class could listen to a tape played on a single machine while each student recorded his responses on an individual machine. This method was adopted in several schools. It produced results that were moderately satisfactory, and "language laboratories," that is, listening and recording rooms, were established in schools throughout the country.

Some teachers, however, still were not satisfied. The equipment was expensive, and maintenance costs were high. Furthermore, most tape recorders have several control knobs, and more than one student who has worked diligently learning to pronounce a Parisian *r* has erased his recording by turning the wrong knob.

Professor William N. Locke, Head of the Department of Modern Languages at M.I.T., began consulting with electrical engineers three years ago, in an attempt to design recording and playback equipment that would satisfy the special needs of language laboratories. Last year a set of mechanical and electronic specifications was prepared. Now the results can be seen in Building 20 at M.I.T. A new electronic

(*Concluded on page 432*)

One student may be practicing Russian, another French, and another German, at any given moment in this laboratory.

The Generalized Electrical Machine

It's a fascinating part of the new curriculum developed under Prof. Gordon S. Brown's leadership in the Department of Electrical Engineering

by DAVID C. WHITE and HERBERT H. WOODSON

"No one will live all of his life," says Margaret Mead, the anthropologist, "in the world into which he was born, and no one will die in the world in which he worked in his maturity."

Nowhere is this more obvious than among electrical engineers. As the inventors, designers, and producers of the devices needed to transmit and employ energy and information, they have been instantly affected by the waves racing through society in the wake of science. Their tools, skills, and concepts are used in nearly every kind of research; their services are demanded throughout all industry. They have been lured, consequently, into a vast array of specialties — radar, biological instrumentation, servomechanisms, nuclear devices, and even the social sciences.

So much had to be added so swiftly to the curricula of schools of electrical engineering during and immediately after the last big war that it became dangerously easy for both teachers and students to be distracted from the core of essential knowledge. The hasty piecemeal organization of new courses called for a major effort to reconstruct the whole program of departments of electrical engineering, so that a young man could maintain the proper perspective during his preparation for a professional career.

This was the problem confronting Professor Gordon S. Brown, '31, when he became head of the M.I.T. Department of Electrical Engineering. The body of knowledge which should serve as the foundation of an electrical engineer's education was no longer clearly defined in men's minds. The speed with which more scientific information was being acquired was increasing. So were society's requirements and industry's opportunities. What, and how, should young men be taught about electrical engineering?

A Conceptual Model

The question was debated both formally and over coffee cups. Scientists and industrialists were consulted, and the General Electric Company, through the General Electric Educational and Charitable Fund, agreed in 1954 to support for three years an effort which, by then, was under way at the Institute, to improve the program and facilities for instruction in electrical engineering.

"Educators traditionally say that their job is to train students to think," Professor Brown wrote. "Equally important is the job of ascertaining clearly what students should think about. . . .

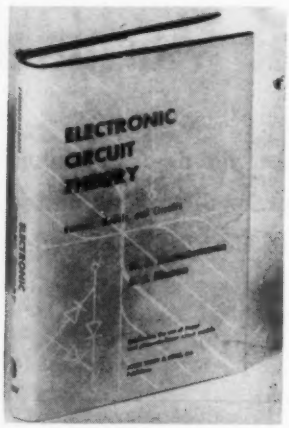
To appreciate this machine, duplicates of which soon will be found in schools throughout the land, one must know a bit about what has happened in the M.I.T. Department of Electrical Engineering. This is a generalized machine, conceived by Professors David C. White and Herbert H. Woodson, '51, whose explanation of the need for it will be found in the article that starts on this page. Shown examining the machine are (from left to right): Paul B. Shiring, who presented this one to M.I.T. on behalf of the Westinghouse Educational Foundation; President Stratton; and Professor White.

"The mission of electrical engineering education becomes clearer if one can visualize a nucleus or a conceptual model of electrical science. One statement of a conceptual model is:

"All so-called electrical devices are manifestations of how a creative engineer has exploited the interactions between charge carriers, their fields and materials.

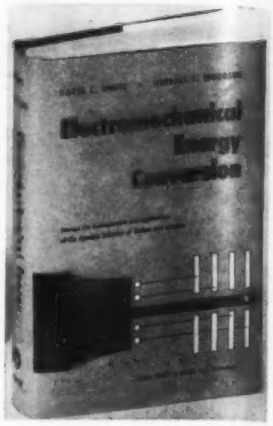
"The charge carriers are ions, electrons, and even the newcomer, the hole. The fields are static and dynamic. The materials interact with the fields by virtue of their physical properties, or magnetic domain structures.

"The engineer's goal in the exploitation of this conceptual model is to bring into existence an array of



ELECTRONIC CIRCUIT THEORY *deals primarily with methods of analysis of electronic circuits. The authors devise models to approximate the characteristics of diodes, triodes, pentodes, transistors, and other control valves. The effect of circuit and signal on device operation is shown by means of locus plots. Basic circuit functions are classified as rectification and detection, wave shaping and amplification, and wave-form generation.*

ELECTROMECHANICAL ENERGY CONVERSION *begins with the fundamentals of analytical dynamics. These are used to analyze typical energy converters. Masses of detail about steady-state characteristics and device design have been discarded in favor of thorough treatment of dynamic characteristics of energy converters, feed-back control system theory, and their interrelations. The generalized machine's equation of motion is derived and used in the analyses of various machines. The book includes a detailed treatment of the dynamics of commutator machines, induction machines, and synchronous machines.*



engineering systems to perform useful functions.

"Such a model touches every facet of an engineer's life, whether in research, in development, in manufacture, as in business."

With this kind of model in mind, the undergraduate curriculum at M.I.T. was overhauled by Professor Brown and his enthusiastic colleagues to:

1. Broaden and deepen the instruction in science;
2. Stimulate creative laboratory work;
3. Subordinate mention of vocational aspects of electrical engineering until after a strong foundation was built; and
4. Recognize differences in students' interests and talents by offering them their choice of many topics for study as seniors.

The New Textbooks

From the moment students entered the Institute, mathematics and physics were emphasized. In the Department of Electrical Engineering, they were introduced first to circuit theory, then taught the fundamentals of information processing and energy processing. Finally, they were offered a variety of more specialized professional courses.

This plan went into effect in 1953. The Class of 1955 was the first to complete the new curriculum. Members of previous classes who examine the program now may find very little of what they studied in it, but are likely to find, the Faculty hopes, much of what they now wish that they had studied.

New textbooks are being used for the core courses. Professor Ernst A. Guillemin, '24, had started to revise *Electric Circuit Theory* before Professor Brown became head of the Department, and his *Introductory Circuit Theory*, published in 1953, became the foundation stone of this part of the program. Two other texts have been published:

Electronic Circuit Theory: Designs, Models and Circuits, by H. J. Zimmermann, '42, and S. J. Mason, '47, and

Electromechanical Energy Conversion, by David C. White and Herbert H. Woodson, '51.

Three more books in this series by men responsible for the course revisions will be available this fall:

Electronic Circuits, Signals and Systems, by Mason and Zimmermann;

Electromagnetic Fields, Energy and Forces, by R. M. Fano, '41, L. J. Chu, '35, and R. B. Adler, '43; and

Electromagnetic Energy Transmission and Radiation, by Adler, Chu, and Fano.

An addition to the core curriculum called "molecular engineering," which was taught for the first time last fall, under the leadership of David J. Epstein, '49, Associate Professor of Electrical Engineering, will probably result in another book in about three years. Critical attention also has been given to the senior elective and graduate courses in the Department.

The Equipment Needed

The new lectures, new books, and new examinations necessitated major changes in the laboratory work, too.

It was possible, in the circuit and electronic laboratories, to give students a large amount of freedom to design their own experiments, because electronic components were available in a form which permitted one to set up a desired circuit in very little time. Circuit experiments include basic measurement techniques, using voltmeters, oscilloscopes, bridges, and so forth, to study the properties of circuits of resistors, capacitors, and inductors. The electronic laboratory emphasizes the use of vacuum tubes and transistors which can easily be interconnected for a variety of applications.

Something different was needed to study energy conversion in the same way. There was not as much flexibility in the choice and use of components. The electrical machines used in the laboratory were conventional types. Many were big and cumbersome, and any dynamic studies placed severe demands on the power systems and measuring apparatus. The authors undertook, therefore, the development of a more flexible piece of equipment to back up their approach in the classroom to electromechanical energy conversion.

So a generalized machine was conceived, developed, and built. It became first one, then another, type of machine when connections at its terminals were changed. With such a machine, students could follow new analytical approaches to electromechanical energy in the laboratory and see the unity underlying all machine types which was being emphasized.

Eight of these generalized units were built in the Electrical Engineering Shop at the Institute under the supervision of Henry J. Laurence, with the funds which General Electric had provided. They were designed for study of the dynamic behavior of electro-

mechanical systems, and this meant that a dynamic torquemeter had to be developed for use with them. Such a torquemeter, based on a magnetostrictive effect, was developed by Michael J. O'Neill, '54, a graduate student. This gave workers in the energy-conversion laboratory some of the same flexibility that was attained with basic electrical components in the circuits theory and electronics laboratories.

Now the generalized machine has become a means of conveying the M.I.T. Faculty's ideas to other colleges and universities. This has happened as a result of a two-week symposium sponsored by the National Science Foundation, with General Electric and Westinghouse help, in 1957. It brought more than 100 professors from other schools to the Institute. During a critical review of the electrical engineering curriculum here, they were shown the generalized machine, and the interest which most of them showed in it prompted the Westinghouse Electric Corporation to put such a machine into production.

Other Schools Benefit

The Westinghouse Generalized Machine's characteristics are superior to those of its predecessors, and its torquemeter is a product of improved manufacturing techniques. The first Westinghouse machine was given to M.I.T. this spring. Now the Westinghouse Educational Foundation is distributing these machines to departments of electrical engineering in 149 other American colleges and universities, to help them develop their electrical energy conversion laboratories.

"Universities have had thrust upon them an ever-increasing responsibility for training engineers in an ever-increasing variety of skills," a Westinghouse spokesman has reminded industrialists. "The traditional approach has been to turn out specialists in specific fields. Now, however, college engineering departments are adapting their programs to a modern concept: electrical engineers must have a broader understanding of the basic science of engineering.

"These modern instruction programs, in turn, demand laboratory equipment as modern as the teaching techniques used by the instructor. We hope our equipment will help meet that need."

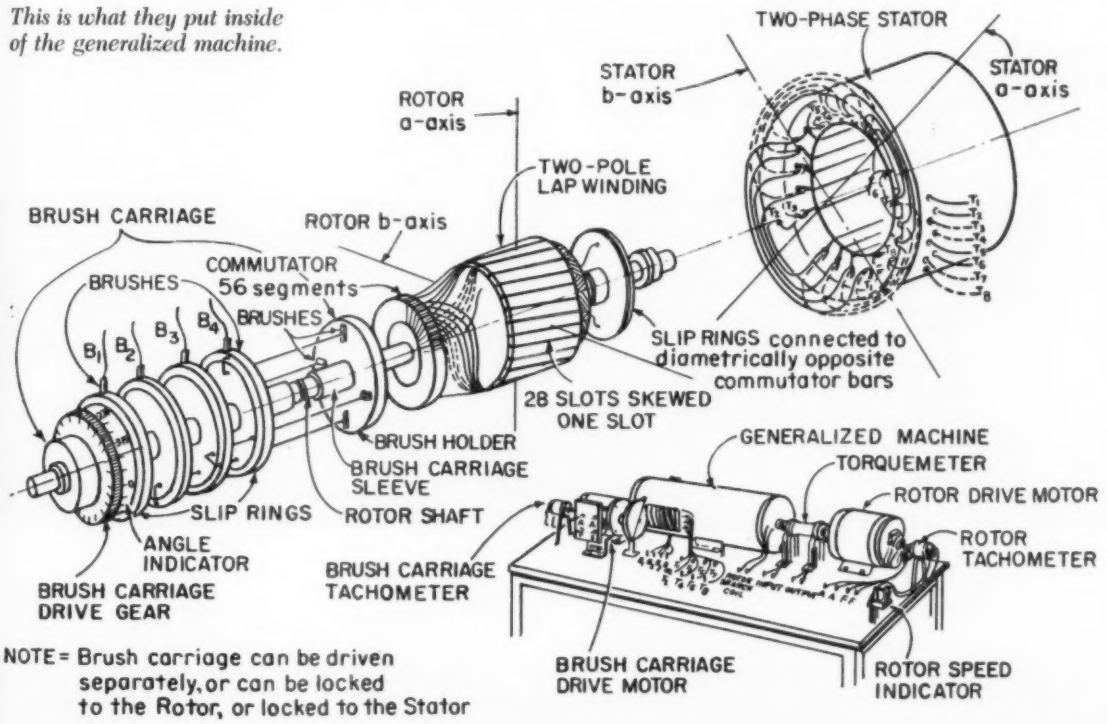
The Next Step

This is but one of the many ways in which industry has helped the schools prepare young men for careers in a rapidly changing world. The generalized machine was only a chapter in a continuing story. Without vigorous Faculty research in energy conversion, the new program will not be secure. Bigger and more open-ended programs of on-campus research are needed now, and industry can help still more by sponsoring such programs.

As Margaret Mead also has observed, education was once mainly *vertical* transmission of tried and true information from an older to a younger generation of men, but now also must stress *lateral* transmission among contemporaries of information about what has just been discovered, invented, created, manufactured, or marketed. Industry-sponsored research in the universities can facilitate the lateral exchanges needed both by the schools and by industry.

A long step forward, taken under Professor Brown's leadership, was nearing completion when he was promoted this spring to the post of Dean of the School of Engineering. Another, possibly bigger, step is being discussed now by the Faculty of the Department of Electrical Engineering, both formally and informally.

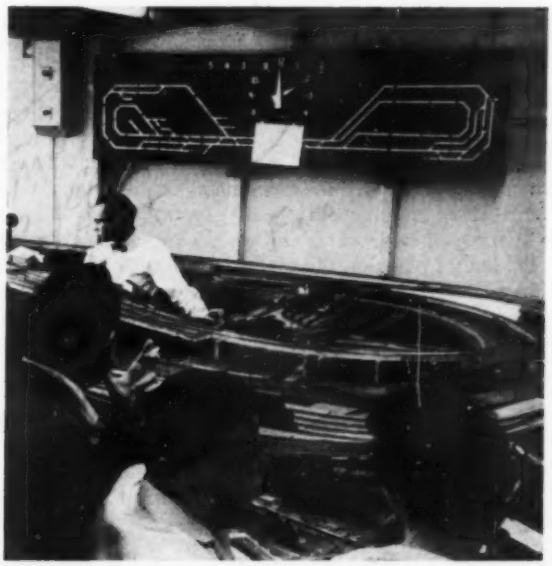
This is what they put inside of the generalized machine.

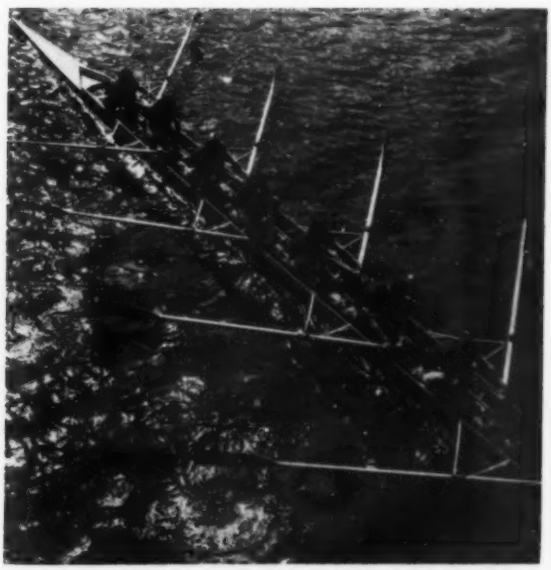


NOTE = Brush carriage can be driven separately, or can be locked to the Rotor, or locked to the Stator

Open House Day at M.I.T.

Thousands of people swarmed through the corridors of M.I.T. all afternoon on Saturday, May 2, to catch some of the flavor of the Institute's educational programs in engineering, science, architecture, the humanities, and industrial management. It was the biennial Open House Day arranged by students, and there were lectures, demonstrations, films, exhibits, refreshments, music, and athletic events wherever one wandered. Colored arrows marked the routes of six different tours of the laboratories, libraries, and departmental displays, and when a fellow's feet gave out he could relax on the lawn and listen to the M. I. T. Concert Band. These pictures tell more quickly than words who came and what they saw and did.





A Proper Environment for Students

For many years the Institute's Alumni have helped it solve the growing and changing problems of housing accommodations

by F. G. FASSETT, JR., Dean of Residence

THERE are many gauges of the evolution of educational institutions. One – particularly apt for such a school as the Institute – is the translation of equipment in laboratories and classrooms. Thus, fondly remembered by many, the Centennial Corliss engine that once stood mighty and massive in the Steam Lab in the ground floor of Building Three has long since yielded its place on the plates to devices of lesser impressiveness though no doubt greater efficiency. So is the growth of knowledge reflected. Another gauge of university evolution is the record of bricks and mortar, especially the bricks and mortar of the buildings where students live. The Harvard Yard presents one of the most comprehensive of records of this kind in the United States.

Things which have been happening lately at the Institute – and others which are in prospect made more immediate by the action of Alumni – give special point to applying this second criterion to M.I.T. in the 43 years that have passed since its transfer from Boston to Cambridge gave the institution new and lasting focus. The record is less lengthy than Harvard's, but appears in many respects fully as varied.

During its Boston years, the Institute was without accommodation for its students. Some resided in fraternities, but most of the men either lived at home or rented rooms as near as they could to "the Tech on Boylston Street." Throughout those years, there had been expressions of the need and desire for better centers for student life. Hence the construction of the L-shaped dormitory surrounding the garden of the President's house on the Cambridge side was regarded as a milestone of much importance. Consisting of six entries, this structure housed something more than 200 students when operations began in November, 1916, fraternities at first occupying the two end units of the building. A. Raymond Brooks, '17, headed the student government organization. Undergraduate enrollment that year was 1,912; hence it is no surprise that pressure for additional dormitory space was soon expressed, and grew stronger as enrollment skyrocketed, reaching in the autumn of 1919 a total of 3,078. In the academic year, 1922–1923, it was recorded that 200 men were housed in the dormitory and 700 in fraternities.

The Class of 1893 then pledged $100,000 for a dormitory unit to accommodate 80 men, to be built to plans by Welles Bosworth, '89, whose genius not only had designed the great central educational structure which is today the core of M.I.T., but also had given to the original dormitory a physical quality and a warm-hearted charm that sets it apart among its fellows today. Ground was broken September 11, 1923, for the building which represents the beginning of alumni concern for undergraduate residence itself apart from general Institute development; in the following autumn, the dormitory unit known today as Bemis Hall was in use. The fraternities had relinquished their tenancy of entries in the first dormitory, and 292 dormitory men were in residence at the start of the 1924-1925 academic year. Leicester L. Hamilton, '14, then began his 25 years of service as chairman of the Dormitory Board. The students housed on campus were still only about 10 per cent of the undergraduate body, and the need for further construction was quite plain.

It was given emphatic formulation by Charles Hayden, '90, the 32d President of the Alumni Association, who in January, 1926, cited the necessity that more 40-man units be built, and that quickly. They would cost $100,000 each, and in March the Alumni Council launched a million-dollar campaign to finance new construction. Soon, Dean Alfred E. Burton returned from retirement to take the lead in the work; by November, 1927, construction had begun; and in

Six entries of the Institute's first dormitory near the President's home were named to honor Faculty members.

The Everett Moore Baker House opened in 1949 is known around the world because of its distinctive architecture.

March, 1928, the two new entries known today as Walcott and Goodale were in use, so that 428 undergraduate men had homes on the campus. The number accommodated had gained on the total registered, but there was still a serious discrepancy, for undergraduate enrollment that spring was nearly 2,400. There was clearly more work to be done.

It took the form of another three-entry structure – the one known in today's undergraduate vernacular as the "West Parallel" – ground for which was broken on March 24, 1930. In October of that year, the building was ready for occupancy, giving the Institute a total of 630 beds for undergraduate students. On February 13, 1931, at a dinner of the Alumni Council with the students living in the dormitories, the completion of the west parallel was celebrated and Dean Samuel C. Prescott, '94, as chairman of a special committee of the Alumni Council to name the new units, announced that they would be known as the Alumni Group.

Those of the east parallel were named for Charles W. Goodale, '75; A. Farwell Bemis, '93, who served as the 17th President of the Alumni Association; and William W. Walcott, '01. The entries of the west parallel honored James Phinney Munroe, '82, who had been the sixth president of the Alumni Association in 1894–1896, and the third Editor of The Technology Review; Charles Hayden, '90, who in 1925–1926 was the 32d president of the Alumni Association, and Kenneth F. Wood, '94.

Undergraduate enrollment at that time – the start of the Great Depression – was about 2,600, and so the proportion that could be accommodated on campus was regarded as considerably more nearly satisfactory than in the past. There was no more undergraduate dormitory construction, in fact, until the pressure of veterans returning from another war made it essential.

Baker and Burton Houses

At the start of the first academic year after the end of World War II, 1,160 undergraduates were enrolled; a year later, 3,811; a year later, 4,138. Barracks accommodations in wartime temporary structures were a partial answer to the problem; another was conversion of double rooms to triple occupancy, and singles to doubles in the existing dormitories. The partial answers taken together, however, were distinctly insufficient. New space had to be had. The decisions taken as a result of this need were a real turning point in the history of the Institute, for they summed up to the decision that it should become a residential university.

The first step was the construction of the dormitory now known as the Everett Moore Baker House, to designs by the noted Finnish architect Alvar Aalto. The Alumni Fund Board appropriated a half million dollars to aid the project. Opened at the start of the academic year 1949–1950, Baker House, which accommodates 350 students, has become known around the world for its architectural distinction. In keeping with the residential objective, its design included a kitchen and dining room for the members of the House, together with ample lounge space. An apartment for a faculty family was also an integral part of the design, self-contained and secluded, yet with convenient access to the main body of the House.

Nearly 1,000 undergraduate men could be housed on campus when Baker opened, and two years later the figure was upped by more than one half by the conversion of the former Riverside Apartments into a dormitory. The Institute purchased the apartment house while Baker House was under construction. When first adapted to dormitory use, it had quarters for nearly 600 students, but this figure was reduced by the later construction of lounge areas. The building is in two main sections: one now known as the Alfred Edgar Burton House, honoring the late Dean Burton; and the other as Conner Hall, in memory of Arthur J. Conner, '88. Largest of the Institute's undergraduate residences, it has been marked by a notable unity of spirit from the beginning.

The four undergraduate centers whose history has been summarized here take care of 1,537 of the 3,587 undergraduate men now in the Institute – about two-thirds of the 2,480 who are not residents of fraternity houses. The proportion has changed markedly from the 1917 situation.

Graduate House

The growth of graduate enrollment at M.I.T., from 42 in 1917–1918 to 2,672 in 1958–1959, has obviously posed new problems of accommodation. These have been especially acute in the years since World War II; graduate registration in 1946–1947 was 1,361, just about half the present figure. Few of the major questions to be resolved at the Institute in the years ahead are more important or more complex than how best to accommodate these men, not merely to provide shelter, but also to secure for them full opportunity for study and the interchange of ideas essential to the richest intellectual development. There is excellent precedent in the arrangements for graduate residence made thus far, even though numbers have outrun them.

In the lean depression years in the early 1930's, undergraduate enrollment was strongly affected, whilst

Edwin D. Ryer, '20
Alumni Fund Board Chairman

Avery A. Ashdown, '24
Master of the Graduate House

Leicester F. Hamilton, '14
Former Dormitory Board Chairman

graduate enrollment held nearly constant between 500 and 600. President Karl T. Compton, to whom the long-term value and necessity of increased graduate study at the Institute were crystal clear, and who had brought with him to the Institute from his Princeton experience deep insight into the potentialities of residence as a stimulus and enrichment of advanced study, led in making an opportunity of this combination of circumstances. Three entries of the Faculty Houses were set apart as a Graduate House, inaugurated at a housewarming on October 7, 1933, when 77 graduate men took up residence.

Of much import was the appointment of Professor Avery A. Ashdown, '24, as Master of the Graduate House. The experiment, unique at the time except for comparable arrangements at Princeton, was so successful that in June, 1934, all six entries were reserved for graduate use, and when the Riverbank Court Hotel at the corner of Massachusetts Avenue and Memorial Drive became available, it was purchased by the Institute and was opened, in the autumn of 1938, as the Graduate House. Today some 450 graduate men are in residence, and Professor Ashdown as Master continues to lead in the program of discussions, house meetings, house dinners, and other occasions in which advanced students from all over the world share ideas among themselves and with other scholars.

The Graduate House has set a goal for all student life at the Institute, however, it may have been overwhelmed by the staggering increase in graduate enrollment. And it is, of course, a bachelors' hall.

The Married Students

In 1917, there was not, in all probability, a married man registered as an undergraduate or a graduate student at the Institute. In 1959, nearly 1,300 of our 6,200 students are married. Over the last few years, married undergraduates have been about 5 to 10 per cent of the total; graduates have made up the rest. The great influx of married students commenced immediately after World War II. Hence in 1945, the Institute, on land west of Massachusetts Avenue, built a village to house 100 families in small temporary houses – Westgate. No sooner finished than filled, it was followed in the next year by the erection of 17 ten-family barracks secured from the Navy – Westgate West. The City of Cambridge co-operated in the venture by permitting – through waiver of the building code – the erection of these flammable temporary structures in a fire zone, and this waiver was continued until this year. The once-temporary structures have outlived their reliability, and the village of Westgate and Westgate West is now in the final stages of demolition. By the end of summer, it will have joined the Corliss engine in the limbo of the past. During its career, 3,261 families, totaling some 14,000 souls, will have lived their student lives there, sharing in the responsibilities of operation, administration, and government through the Westgate Council. As the Long-Range Planning Committee considers what may yet be done in the use of Institute land in the effort to provide a homelike environment for some if not all married students, it is to be hoped that further opportunity for this kind of civic education will be part and parcel of the program.

For Women Students

For the distaff side of the Institute's student body, the first residential provision was made under the leadership of Mrs. Karl T. Compton in 1946, when a dwelling at 120 Bay State Road in Boston became the M.I.T. Women's Dormitory, with 17 women students and a house mother in residence. Ten years later, the Women's Dormitory was reserved for first-year women students. For the upperclasswomen and graduate women, a section of the Bexley Hall apartment house, opposite the Rogers Building on Massachusetts Avenue in Cambridge, was taken over and equipped as apartment quarters for groups of two or three women.

Begun frankly as an experiment, the plan has met enthusiastic response. Thirty-three women can be housed in the structure; undergraduates and graduates are about evenly divided in the group. Government of the house rests with an elected house committee and a member of the Faculty and his wife are in residence in the house.

The Fraternity Houses

In the male undergraduate world at the Institute, the kind of co-operative accomplishment in self-government seen at Westgate was long ago achieved by

(*Continued on page 422*)

Lessons from the History of Flight

An aviation pioneer describes wrong trends, unrealized, and right trends, unappreciated

by GROVER LOENING

Here is part of the Lester D. Gardner lecture delivered at M.I.T. this spring by Grover Loening before a distinguished group of aviation pioneers. Mr. Loening was the first aeronautical engineer employed by the U. S. Army, a founder of the Institute of the Aeronautical Sciences, Pan American Airways, and the Grumman Aircraft Engineering Corporation, and now is director of the Flight Safety Foundation and consultant to the Navy and Air Force.

THE growth of U.S. air transportation from nothing in 1920 to 24 billion passenger miles in 1958, is merely a beginning. We will shortly progress into supersonic flying – all over the world.

There is much left to do to perfect our utilization of the air ocean in which we live. Tolerable noise, vibration, and acceleration must accompany supersonic flight. And greater saftey!

Some clear and not too pleasant lessons are to be learned from a questioning and reflective perusal of the more than half century in which we have developed our air travel, air logistics, and air road-to-everywhere usage. One of the most outstanding lessons that we see clearly, in such a review, is how often designers and constructors have failed to finish up what was started.

Many a novel but highly significant development, idea, or suggestion has lain on our doorstep for years, unappreciated. Let us look at examples:

In America, where flying was born, the biplane type of flying machine dominated our picture from the very start for almost 25 years, despite the obvious success of the monoplane in France and the fundamental correctness of its aerodynamics. Today the monoplane, strut-braced or cantilever, has completely swept the field in all types and sizes, and the only biplane left is occasionally seen towing an advertising sign or doing crop dusting.

In earlier years, landing gears started with skids to which wheels were added, but the skids were left on, only to become the cause of many wrecks when they broke on hard landings. From the very beginning, wheels alone were, obviously, correct. In Europe, Blériot, and in America, Curtiss, were outstanding in realizing this, and in the case of Curtiss the practical three-wheel gear was constantly being demonstrated as successful. Practically no one else saw this. Even Curtiss gave it up. And yet some 35 years later the three-wheel gear with level fuselage configuration is found in practically world-wide usage.

Variable-pitch propellers were suggested at an early date – a practical one by Hamilton in the 1920's – but it took 8 or 10 years for them to come into wide and general use.

Shown above, after the Lester D. Gardner lecture which was delivered in Kresge Auditorium on April 10, are (in front, left to right): Luis deFlorez, '11, Grover Loening, Jerome C. Hunsaker, '12. Standing: Elmer Sperry, Jr., Edwin E. Aldrin, '17, Commander F. G. Coburn, '07, and Rear Admiral C. E. Rosendahl.

Engine Positions

On the early configurations in America, engines were at the side of, or behind, the aviator. In the case of the original Wright design, two large geared-down propellers were needed to translate 12 horsepower into effective enough thrust to fly 800 pounds; in fact, this was one of the secrets of this plane's success. As more powerful engines came along, the gearing down was not needed, but the engines remained behind the pilot.

Safety in crashes was, of course, the outstanding reason for the adoption of the tractor-type. In the early planes, when they were in the 40 miles per hour category, the seats were not enclosed. The advent of the fuselage with enclosed seating was stimulated, of course, by the use of the tractor engine. But it is remarkable to note that the obvious further streamlining and closing in of the fuselage lagged for a few years. Nieuport, in his remarkable and revolutionary little monoplane of 1910 which swept the field in competitive performance, practically started this vogue. But it was not really until some 10 or 15 years later that the majority of the aviators, including the military, had

The author designed this Hispano-Suiza powered, two-place fighter for the U.S. Army Air Corps during World War I.

discovered that they need not have their heads out in the open air in order to fly.

Flaps and slots to slow down landing speeds, or rather, to permit higher cruising speeds and heavier loads without too great a landing penalty, kicked around, too, for a long time – much too long.

Materials of Construction

Materials of construction of aircraft have gone through many cycles. Even for several years after World War I, and in spite of the Zeppelin duralumen development, aluminum was suspect as a structural material. So much so that the famous Specification 100-A of the Navy prohibited the use of aluminum in any structural part of aircraft. This was a pertinent example of how too rigid specifications, based on what was good practice in previous years, can prevent future development.

Today we face a similar situation in prohibitions against fiberglass or plastic-stressed structures because it is so difficult, theoretically, to calculate and check the stressed condition. Yet plastics may well have as great a future in aircraft structures as dural-stressed skin monocoques and wing panels had 30 years ago. New alloys – titanium and others – are beckoning alluringly, like fiberglass, for a chance to show their worth. Also "sandwich" materials are most promising. Will we still be slow to pick up the ball?

The lesson one seems to gather from these and many other instances is the unpleasant one that aviators' likes and dislikes were given too much weight, and hence discouraged the engineers from perfecting their developments. In retrospect, one finds many instances where worthy developments were ignored or abandoned because they were politically, in a public relations way, unwise. Many a wing flutter that scared a test pilot condemned to utter oblivion an airplane that had structural or configuration features of great importance and advantage. Had the customer and the builder been patient or wise enough to work out such bugs, success would have followed more quickly.

On the other side of the picture, many an airplane with little commercial or military value was for years used in a most popular way because the upholstery and the windshield were well worked out, and because a lucky combination of slip stream and wing flow (totally unforeseen by the designer) gave unusually good control on landing – which made it easy for the pilot. Another personal prejudice revolved around ease of egress in case of accident.

Bureaucratic Drags

As the years went on and brought more scientific engineering appraisal of new aircraft in test flying, there grew up other drags on development, causing unnecessary time lags from day of inception to the hardware-in-use stage. These were largely bureaucratic.

In 1926, after the original Civil Aeronautics Act, reinforced by the later enactment of 1938, the government was put into the position of passing judgment on the aircraft that our industry wished to sell to the public, by establishment of the Certificate of Air-Worthiness procedure. At the time, we, unthinkingly, accepted this, largely because of the supposed great risk to which a gullible public would be subjected if offered all kinds of aircraft that might fall apart in the air.

And then the bureaucracy really got to work. The inspection and engineering staffs of the Civil Aeronautics organizations of the government had to grow with each page of more and more detailed specification called for by Congress and law. But here is the fallacy: by necessity, such specifications had to specify last year's aircraft, because the authors of such specifications were not inventors, or developers in the imagination business. Here is an example:

After World War II, in 1946, Robert Fulton designed and built in Connecticut an interesting new aircraft called the "Airphibian," in which the body contained the engine, and was a perfectly operable small car from which the wings could be detached. Fulton never complained, but went through the Civil Aeronautics Certification procedure. He was a very expert designer and skillful builder. He would have had an immediate market from 1947 to 1950, but it was not until 1952 that he had managed finally to finish up completely the Civil Aeronautics procedure, and then it was too late. And when it was all through, the procedure had caused practically no changes whatever in the aircraft, but had changed many, many pages of Civil Aeronautics rules by waivers and allowances. Not all cases of C.A.A. certification have been as bad as this, and recently there has been much improvement – not in the law, but in the more liberal way the old C.A.A. and now the Federal Aeronautics Agency are interpreting their mandate.

The automobile in the hands of the public is fully as dangerous as aircraft, and yet there is no Washington government bureaucracy that requires each new model to have a "Certificate of Road-Worthiness." Companies that have survived have done so only by the most careful designing and the most exacting test procedures of their own.

Here is a lesson that we could apply to small-sized, private vehicle aircraft almost at once. Of

course, when we contemplate huge air transports carrying over 100 passengers, aircraft growing to the stature of shipping, some government inspection and certification may be needed.

In this certification and inspection area, should not the insurance companies take a much greater role – as Lloyds does in shipping? Let us think hard on any system that will get us away from a cumbersome governmental one.

Another bureaucratic drag on progress is in the military – in the system involved in what the Air Force calls "the Requirements Division." Here we are supposed to have the finalized requirements for new aircraft. For purely military items, such as the need to carry a larger gun or a different kind of bomb, this is fully justified. But it has unconsciously been extended by the Pentagon bureaucracy to cover too many broad features and types of aircraft.

Had an inventor appeared at the Requirements Division of the Air Force as recently as 1953 with a very effective way to muffle the noise of aircraft power plants without sacrifice of performance, the bureaucratic system would have informed him: "There is no requirement for such a development." Of course, very intelligent and progressive officers sometimes alter these procedures on their own, and a new requirement is, in too rare instances, created.

Russia seems to move quicker in reaching the hardware-in-use stage after early inception. As near as we can ascertain, the Russians do not use our system. This we had better study. Instead of a "Requirements Division," we had perhaps better have a "Stimulation Division."

Aircraft Operation

Let us look at today's aircraft operation for some more lessons and possibly anticipate some future troubles.

Today all aircraft can be spun and recovered with safety; 45 years ago, this was not the case. As a matter of fact, up to 1913, the "spinning nose dive" or the deadly "spiral dive from air pockets" was the disheartening cause of accident after accident. At Dayton in 1913, we were the witnesses of a very vital historical moment in airplane operation. This was when Orville Wright, so discouraged by the accidents that were happening to his exhibition fliers and to a whole series of Army fliers (Hazelhurst, Love, Kelly, and others), was determined to test out what was happening.

It was not long before he, himself, came back from these test flights smiling instead of grim, because he had discovered what a "spin" was, and how to get out of it: by pushing forward on the controls – and why so many aviators had been killed: by pulling back on the controls at the wrong time.

Now, some 46 years later, when we begin to fly through the sound barrier, we discover a brief moment when controls are reversed. And also today we are somewhat plagued by "pitch-up" in the control of supersonic aircraft. Recently a jet air liner suddenly dove 29,000 feet. Are we seeing

A Loening amphibian, now in the Smithsonian Institution, was one of the first U.S. planes with retractable landing gear.

manifestations of some new operational characteristic of swept-wing aircraft which may require some additional controls other than the ones we have provided?

The operation of aircraft has become very complex, due to the constant addition of more and more instruments. We have gone a long way from our first instruments – the string for sideslip, wire whistling for speed, and the railroad track for navigation!

Are our present instruments really the ones we should have? Has not the barometric altimeter caused us so many accidents that we should long ago have gone to something better? Our automatic pilots are all based on known flying procedures. What if the new types required some new controls of flying procedure, or crossed controls to prevent "pitch-up" or to prevent the swept-wing dive? It is exactly in such areas that we are much too complacent and that we leave lying on our doorstep, without enough concern therein, problems that should alert us more quickly to the utmost inquiry.

Our Noisy Airports

Noise abatement is now very noisily clamoring on our doorstep, but we should learn from our history that abatement is not now the answer. The answer is to design a power plant with a fundamental limit on noise, in its original design, such as there is on its fuel consumption and weight. We can soundproof against internal noise rather well in a cabin, but external noise has made the airplane a very undesirable neighbor, even to the extent of having it ruled out in many places. Have we, through these formative years, appreciated this enough? This one can be answered quickly: we certainly have not.

Literally billions of dollars are being spent on airports around the world. In too many instances, particularly in America, these are one-runway airports; in other words, a one-track railroad. It is difficult to understand why this is so, when we stop to remember that whole squadrons of aircraft during World War II (and still now) land on reasonably wide runways within a few feet of each other at the same time, and similarly take off in formation. Why then should not an airport have at least

three runaways in each direction, and land aircraft three at a time?

The hesitation on this is typical of our complacent thoughtlessness. There is no danger involved. Thousands of times a day the pilots of large transports land their planes accurately and within a few feet of the centerline of runways.

The Jet Plane Development

The jet planes of the day in America are not being developed in the same way that they are in Europe in one particularly prominent characteristic: this is the location of the jet engine. The Douglas DC-8 and Convair 880 have followed the lead of the Boeing 707, which naturally followed the lead of the B-47 and the B-52. Unfortunately, these leads seem to derive from the old position of piston engines in nacelles mounted outboard on the wings. Here we have a very typical illustration of a lesson not learned from the history of our art. For a jet engine this location is not good. Jet engines are very light, so the structural saving in spreading the weight over the wing is very much less than it is in the case of the piston engine. Also there is no propeller clearance requirement. But the engines are now located so low that they will ingest any loose material on the runway with great risk to the delicate turbine engine interiors.

The outboard engine is so low that a tire or wheel failure on one side would come near to breaking it up on the ground, followed possibly by fire from the gas tanks above it. The position of the engine under the wings makes the wing a perfect sounding board to disturb the neighbors below, and the inboard engine is so located that its noise cone hits the rear of the fuselage, making it almost untenable. The builders and operators are aware of these features and are doing all they can still to give us excellent safety.

In Europe, most of the newer commercial designers completely separate themselves from all piston-engine concepts by placing the jet engines where they belong: above the wing and to the rear, mounted to the fuselage, leaving the wing with perfect aerodynamic cleanness. Maintenance also is improved by this location.

The biggest revolution in the coming design of useful aircraft will be in the advent of the direct-lift airplane, sometimes awkwardly called VTOL (vertical take-off and landing). After some 10 years of intensive research, resulting in several bookshelves full of excellent National Advisory Committee for Aeronautics and other laboratory reports on how to do this trick (of making a fast airplane land vertically), it is only this year that we are beginning to show the needed interest and the beginnings of progress in this development. Boundary layer control is only one facet of this. Tilting wings, tilting jet engines, and other ways are being developed.

The helicopter does not quite meet the bill, simply because its high speed is limited due to the rotor configuration. Even if helicopters get up to a high cruising speed of 200 miles per hour, they will still, at that time, have to face fixed-wing aircraft of over twice that speed. Slow aircraft, no matter for what purposes, have never survived.

Fuel, Weight and Time

There are many objections to lift-planes (VTOL) now being voiced. One is that the fuel consumption for vertical flying is utterly prohibitive. In the light of history, this belongs with the objections that were raised to monoplanes, to metal construction, and to slots and flaps.

A simple analysis will show quite quickly that while direct-lift by jet will need three or four times the thrust of the existing jet engine configurations — and will, therefore, use three times the fuel — the actual fuel used by the jet transport in taxiing out to the end of a long runway, waiting for clearance, then the long take-off run, then climbing to 1,000 feet is, if anything, more than the direct-lift plane would use for a few short moments rising immediately from its pad at the loading ramp with all engines full-out, to 1,000 feet, and then shutting off its extra lift engines.

Another argument, in the same class as these old shibboleths, is that extra weight is involved in heavy extra jet engines for vertical thrust. Actually, vertical lift capability means a much lighter landing gear, so the weight of the extra jet engines that are needed for the vertical operation could represent no more of a burden to the aircraft than the landing gear. Originally, this represented 6 to 10 per cent of the empty weight of the aircraft, used only for a short while on landing and take-off, whereas the extra jet engines could be used, in a pinch, if the other power plants failed, or for quicker climb.

And with the ability to rise vertically and fly fast, the lift plane, in smaller sizes (if not too noisy) would at last penetrate the open and fertile field of private vehicle aircraft, which has hardly been touched.

Immediately, when we contemplate many different designs of aircraft for vertical lift and high speed, we find that the gas generator (the jet engine power plant) will most likely become a very intimate part of the wing. In fact, the final requirement from the gas generator is for a forced lift flow around the wing, including boundary layer control. For the slow-speed regime, a large volume of air moving more slowly (400

(Concluded on page 434)

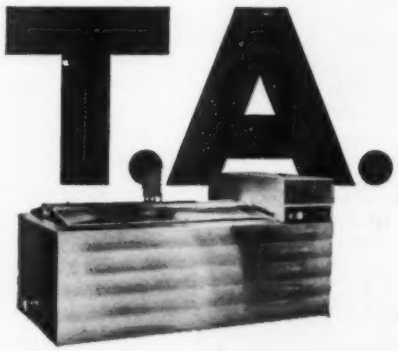
Annual lectures at M.I.T. on the history of aviation were provided for by a bequest of the late Lester D. Gardner, '98, who was also instrumental in establishing the Hunsaker Professorship in Aeronautical Engineering. Major Gardner was president for 10 years of the Gardner Publishing Company and for four years was chief executive officer of the Institute of the Aeronautical Sciences.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

The initials T.A. stand for Technical Advisor. This is not a fancy title for the Revere representatives who call on prospects and customers, but rather one that designates the man having that title as being thoroughly schooled and qualified to aid manufacturers in the proper selection of non-ferrous metals.

To be a Revere Technical Advisor a man must be completely conversant with metallurgy and its application to present-day production. And, if you ask him the type of question that cannot be answered on the spot then he is qualified to present the problem to Revere's Research Laboratories in a manner that will result in a satisfactory answer.



To show you how Revere's Technical Advisory Service can render you valuable aid we cite the following example: Years ago the country's oldest manufacturer of milk coolers came to Revere with the idea of building copper-lined coolers to supplant their galvanized ones which had produced corrosion and other problems.

Revere's Technical Advisory Service worked with them in the designing of a satisfactory product. It took time, plenty of time, and experimentation. But the result was well worth the effort . . . a deoxidized Revere copper for the lining and Revere Copper Tube for the heat exchangers. But Revere's service did not stop there. For in order to keep down costs the manufacturer called on Revere's Technical Advisory Service, from time to time, to help them redesign their cooler for greater efficiency and economy. Revere Research also showed this manufacturer how to overcome their soldering and welding problems.

Because of the continuing efforts of Revere's Technical Advisory Service, in connection with Revere's Research Laboratories, this manufacturer is today in the position of being able to offer a most efficient cooler at the least possible cost. Claims of this manufacturer for this cooler are that it will cool milk, uniformly from top to bottom without mechanical refrigeration and electricity. That the cream on top will never warm up. That the cooler produces continuous 24-hour cream line cooling which removes the heat from the cream line on the top as well as from the milk on the bottom. That temperature of the milk always goes down, never up, between milkings...not one B.T.U. of heat that passes through the side walls or the bottom ever reaches the milk. This is still another example of how Revere's Technical Advisory Service was able to fit the metal to the job in order to produce a superior product at the least possible cost.

Practically every industry you can name is able to cite similar instances. So we suggest that no matter what your suppliers ship you, it would be a good idea to take them into your confidence and see if you cannot make a better product at lower costs by specifying exactly the *right* materials.

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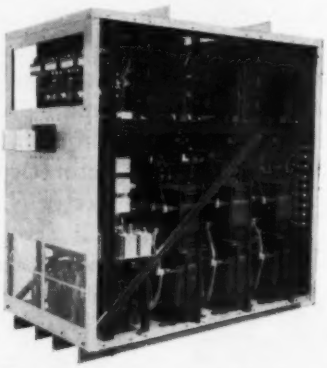
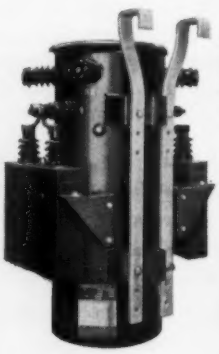
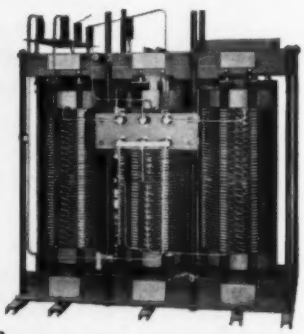


CONSTANT CURRENT REGULATOR used in an industrial electrochemical process.



CONSTANT CURRENT REGULATOR for street, subway and airport lighting.



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TALK OF OUR TIMES

Political Institutions Can Be Improved

When the New York Young Republican Club presented its 1959 War Memorial Award to Thomas C. Desmond, '09, this spring, he called for more participation in politics by honest, well-informed citizens. Mr. Desmond served for 28 years in the New York State Senate. He was president of the M.I.T. Alumni Association in 1930–1931 and is a life member of the M.I.T. Corporation. In his talk to the Young Republicans, Mr. Desmond said in part:

■ In previous generations the United States had to fear but relatively little the results of bad politics and bad statesmanship. But in this hydrogen bomb age those evil twins may lead us to catastrophe.

Let us contrast conditions as they are now with what they were say only 50 years ago. During this short span of time we have seen the development of automobiles, aviation, radio, labor-saving devices, and other technological improvements which have made our country now technologically so superior to what it was a half century ago.

But who can honestly say that the quality of our government has improved comparably in the last 50 years? Meanwhile government has become increasingly complex and important affecting much more the daily lives and happiness of all of us than it did 50 years ago.

One of my responsibilities for many years has been to serve as a life member of the Corporation (governing board) of the Massachusetts Institute of Technology. Naturally, therefore, I am reasonably familiar with continuing technological improvements. My hope is that more capable minds, of the kind which during recent years have produced so many technological improvements, during the years to come will be devoted to the so greatly needed political and governmental improvements. Machines are important but men are more important. Technological improvements are important but improvements in the art of human relations are even more important. A world that knows television should not still know bayonets.

Men and women are likely to attain happiness if they are motivated in large part by deep, underlying desires to spend much of their lives in useful service. What more surely useful service can a man render to his fellow men than by assisting in maintaining and strengthening our precious democratic institutions?

Our economy and culture are changing rapidly from year to year due to frequent technological improvement. Our political and social institutions need also to be improved constantly in correlation with technological improvements. Unfortunately, political and social improvements seem to be lagging behind.

Our cherished democratic institutions will benefit when more capable men and women are willing to give part of their time to serving as members of school boards, party committees, city councils, delegates to political conventions, or members of the national or

(Concluded on page 420)

COMMAND DESTRUCT

The flight testing of second generation missiles—more versatile and powerful than their predecessors—requires a device for sure termination of any missile flight that might endanger the test range or surrounding area.

Ramo-Wooldridge engineers, under a United States Army Signal Corps contract, have successfully developed and delivered the first sub-miniature, completely transistorized radio "command destruct" receivers.

Specifically designed for missile flight safety operations, the receiver (AN/DRW-11) can actuate safety mechanisms or destruct devices. It has three command channels, each of which actuates a control relay.

The "command destruct" receiver accepts frequency modulated signals in the UHF radio command control band. It is designed to operate with closer radio frequency and command frequency channel spacing than has been used to date, thus making possible more efficient use of the available radio spectrum.

Compact and rugged, the radio receiver's modular construction permits rapid and complete accessibility to all components. One module houses the basic receiver. The second module contains the three command channels and relays. This integrated package occupies 115 cubic inches, and weighs 4 pounds. The receiver requires no pressurization and operates reliably under the adverse environmental conditions encountered in missile flight testing.

Engineers and scientists interested in being associated with some of the nation's most advanced research and development programs are invited to acquaint themselves with current opportunities at Ramo-Wooldridge. The areas of activity listed below are those in which R-W is now engaged and in which openings exist.

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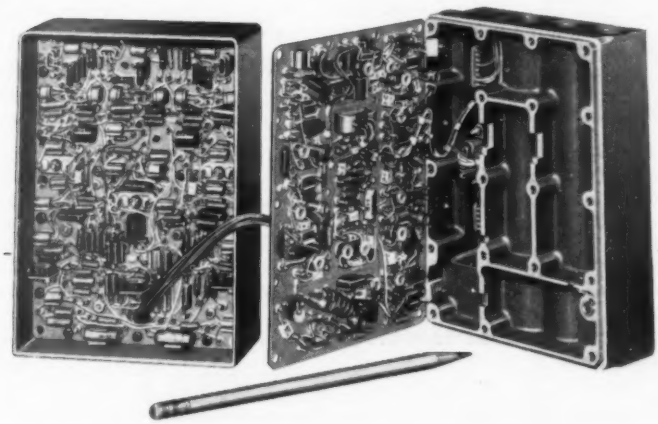
For a copy of our brochure, *An Introduction to Ramo-Wooldridge*, or other additional information write to Mr. Donald L. Pyke.



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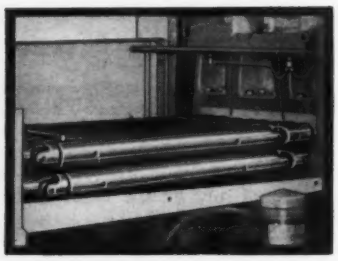
How Curtis solved a close center-to-center problem



The close center-to-center spacing of these drive spindles on a Sutton-Maust Precision Backed-up Roller Leveler created a tough problem for its manufacturer. He needed a universal joint strong enough to stand up under heavy rolling mill conditions, yet small enough to operate at such close quarters.

The answer was a Curtis universal joint! The maximum load carrying capacity and minimum torsional deflection of the Curtis joint was found to be completely satisfactory. And Curtis' famous Telltale Lock Ring construction permits quick disassembly for easier maintenance.

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TALK OF OUR TIMES

(Concluded from page 418)

state legislature. It seems especially important also to emphasize the desirability of becoming active in the party organization of the political party of one's choice in one's own community. No one can maintain that a man is not derelict in his civil obligations who does not at least vote on election day. But just voting on election day is not nearly enough. By activity in party organization work a citizen has a share in selecting the candidates to be voted for on election day and in shaping party politics.

One who joins his local party organization may have frustrating difficulties at first but there is a satisfaction in overcoming obstacles. A man's motives in politics may be misunderstood by some and misstated, but others will understand and will approve. I have particularly in mind the type of political organization activity in early years which does not necessarily involve holding public office but enables one to have influence in selecting well-qualified party candidates for public office.

Politics, another name for government, will approach more closely the ideals of George Washington, Alexander Hamilton, Thomas Jefferson, and other founders of our republic, when more constructive-minded Americans are willing to take an active part in politics not for what they selfishly receive but for what they can unselfishly give.

SPECIAL REPORT

Mr. RULON E. RASMUSSEN NEW YORK LIFE AGENT

at PHOENIX, ARIZONA, GENERAL OFFICE

BORN: April 7, 1923

EDUCATION: University of Utah, George Washington University, Business and Law Schools.

PREVIOUS EMPLOYMENT: Member of U.S. Senator Elbert Thomas' staff. Staff member Senate Education & Labor, and Military Affairs Committees, 1943–1947.

REMARKS: One key factor in Rulon Rasmussen's successful transition from legislative fact-finding to life insurance selling was his fine business and law school background. This background and his congenial personality have helped Rulon top the million-dollar sales mark every year since 1949, the year after he became a New York Life representative. Today he is a Qualifying and Life member of the insurance profession's Million Dollar Round Table and has earned membership in the Company's Presidents Council—an honorary organization of New York Life's leading agents. If past experience is any indication, the years ahead look bright indeed for New York Life representative Rulon E. Rasmussen.

Note

Rulon Rasmussen, like so many other college alumni, is well established in a career as a New York Life representative. It offers him security, substantial income and the deep satisfaction of helping others. If you or someone you know would like more information on such a career with one of the world's leading life insurance companies, write:

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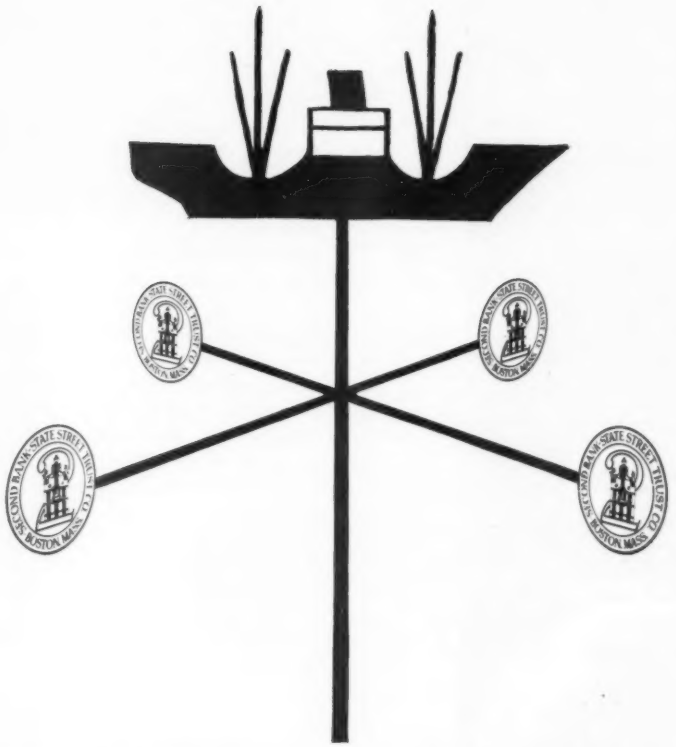

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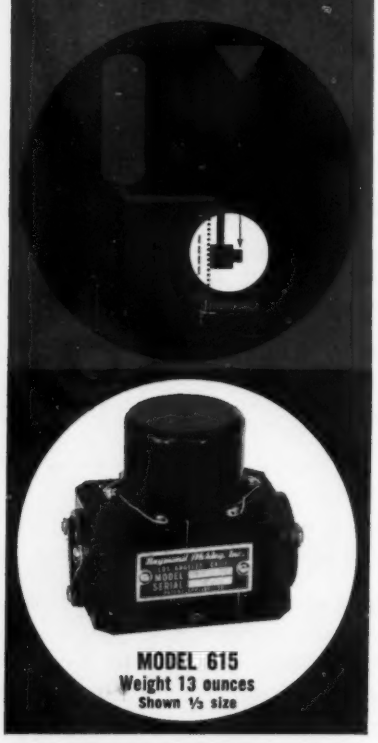

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PROPER ENVIRONMENT FOR STUDENTS

(*Continued from page 412*)

the fraternity chapters, which now are home to some 1,100 students. It is fair to say that the Institute's Interfraternity Conference, the central governing body of the fraternities, is among the leaders of its kind in the country. It is cited as a model by not a few deans of neighboring institutions. Through it the 28 chapters collaborate among themselves and with the Institute in matters of scholarship, conduct, social affairs, athletics, recreation, and the operation of joint purchasing.

Of the chapters, all but four, together with the ably operated M.I.T. Student House, a co-operative venture, are located in Boston or Brookline, some as near as a 10-minute walk to the campus, others at considerable distance. With the marked enhancement of community life on the Cambridge side of the river which has come about through the expansion of the athletic fields, the great increase in musical, theatrical, and other educational and recreational activities fostered by the Kresge Auditorium, the focusing of spiritual and religious concerns in the Chapel, and indeed the building up of a sense of place and permanence through the presence of 2,000 men in residence in the Graduate and Undergraduate Houses, the desire of many fraternities to find accommodations on or near the campus has become stronger. The problems involve sites, the high cost of building, ways of finding funds for building, and taxes, but serious and consistent efforts to solve the problems are under way.

The Master Plan

To return now to the Undergraduate Houses: Partly to provide the greater contact between students and Faculty which has been stressed by students as a great desideratum, partly to foster a feeling of continuity in the Houses themselves, partly to aid in the growth of student responsibility and self-government in the Houses, and primarily to facilitate in the undergraduate world the opportunities for social and cultural growth which Professor Ashdown as Master has emphasized in the Graduate House, the Institute in 1951 brought married members of the Faculty into residence in the Houses. Over the years, 10 Faculty families have spent a year or as many as five years thus. With the student house committees they have

(*Concluded on page 424*)

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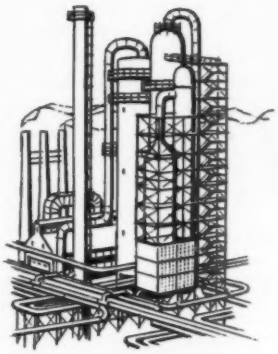
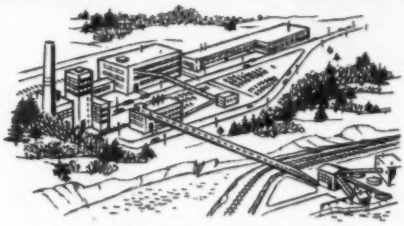
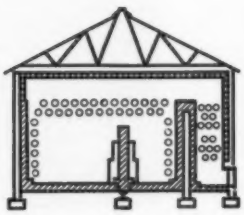


Petroleum Refineries

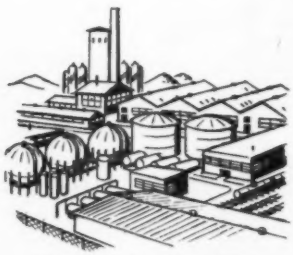


Pulp and Paper Mills

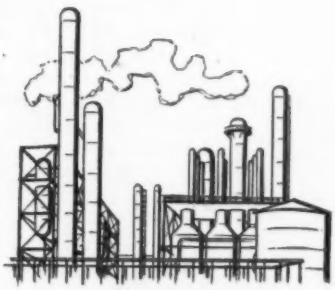


Oil Heaters
(Oil Heater Division)

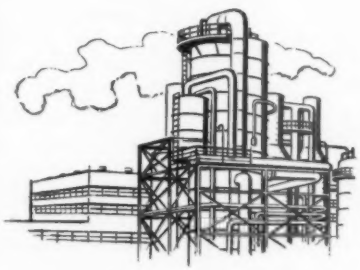
Economic Study and Consulting Services



Agricultural Chemical Plants

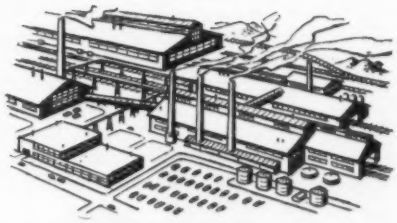


Petrochemical Plants



Chemical Plants

Pilot Plant Work
(Engineering Development Center)



Metallurgical Plants

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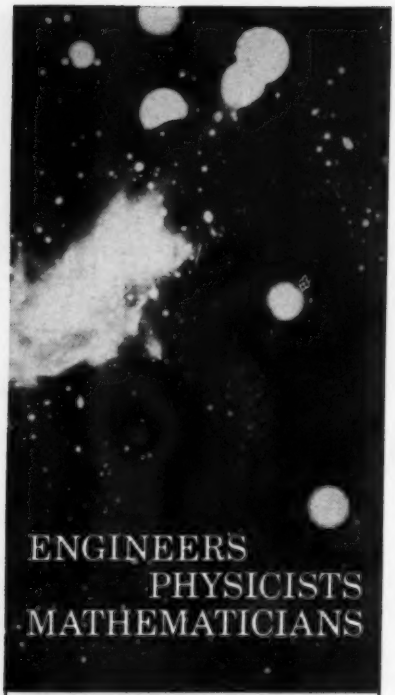

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We are interested in engineers with backgrounds in other fields as well as avionics, aircraft and missiles.

For further information write to Mr. C. C. LaVene, Douglas Aircraft Company, Inc., Santa Monica, California. Section N.

the most respected name in aircraft, missile and space technology

PROPER ENVIRONMENT FOR STUDENTS

(*Concluded from page 422*)

worked for the general betterment of undergraduate life, in ways ranging from teas and dances to lectures and seminars. With individual students they have served as guides, philosophers, and friends when needed. Friendships have thus been built up which long outlast graduation and departure.

The logical extension of this plan was the initiation last autumn in Burton House and Conner Hall of the "Master plan," under which Professor Howard R. Bartlett, Head of the Department of Humanities, became Master of the House, and took up residence there with Mrs. Bartlett. Two junior professors as Senior Tutors and six teaching assistants as Tutors joined the program, becoming residents of the House. So successful has the result been that in the autumn of 1959, John B. Goodenough, for several years Faculty Resident of the Senior House, will become Master of the House. He and Mrs. Goodenough will continue in residence there, and will be joined by a resident Senior Tutor and four resident Tutors.

The Next Step

With a Faculty that is largely nonresident — in part because of the geography of Cambridge — the way to increase student-Faculty contact is for Faculty to move not simply into Cambridge, but actually on campus as this plan provides. It will be extended to the other Houses with time. Facilitation of it has been made possible in no slight measure through the support of the Alumni, specifically through the allocation of substantial Alumni Fund money to the development of the residential system as was announced recently by John J. Wilson, '29, President of the Alumni Association, and Edwin D. Ryer, '20, chairman of the Alumni Fund Board.

It is this support which makes possible, too, the breaking of ground this summer for the construction of a kitchen and dining room for Burton House and Conner Hall which will make this undergraduate center truly self-contained — a place where undergraduate life may be lived to the full. The plans for the dining room, which will be built on the north side of the building overlooking the playing fields, are such that it can be used as a meeting room for lectures and discussions, and as a pleasant and commodious place for dances and other social affairs. The students now in residence in Burton House and Conner Hall are contributing ideas and suggestions to the planning. In this they are working both with the House committee and with the House senior honorary service society known as Burcon.

No more significant note could be found for the conclusion of this survey than the creation of the Burcon society by a group of seniors five years ago, with its goal that of service and support for the good life for all members of the House, and the emulation of Burcon by the establishment this year of a comparable group in Baker House, by the name of the Everett Moore Baker Society. In this sort of thing, the House system at the Institute comes of age.

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TREND OF AFFAIRS

(*Continued from page 403*)

Individuals Noteworthy

■ Named in the news recently were the 27 Alumni and members of the Faculty whose elections, promotions, and appointments are recorded below:

Maurice R. Scharff, '09, as a Director, Duquesne Light Company, Pittsburgh . . . *Neal T. Tourtellotte, '17,* as Regional Director, District XIII, U. S. Small Business Administration . . . *Theodore W. Bossert, '20,* as a Vice-president, Aluminum Company of America;

Harold R. Boyer, '22, as Director of Military Products, General Motors Corporation . . . *Allen S. King, '22,* as President, Edison Electric Institute . . . *Carl W. Shattuck, '22,* as President, McKiernan-Terry Corporation, Harrison, N. J.;

Hugh S. Ferguson, '23, as President, National Research Corporation . . . *Walter F. Munford, '23,* as President and Chairman of the Executive Committee, United States Steel Corporation . . . *Carl F. Muckenhoupt, '24,* as Director of Research, Northeastern University;

Carleton Shugg, '24, as President, Electric Boat Division, General Dynamics Corporation . . . *Charles S. Draper, '26,* as Chairman, National Inventors Council, U.S. Department of Commerce . . . *Edward M. Tittmann, '29,* as Executive Vice-president, American Smelting and Refining Company;

Claude F. Machen, '31, as a Vice-president, Boston Gas Company . . . *Emile M. Bustani, '33,* as the delegate of Lebanon to the Arab Petroleum Congress . . . *Richard S. Morse, '33,* as Director of Research and Development, Department of the Army;

Richard Robinson, '33, as President, Massachusetts Broken Stone Company . . . *Professor John G. Trump, '33,* and *Robert J. Van de Graaff,* Associate Professor of Physics, as Directors, Goodrich – High Voltage Astronautics, Inc. . . . *Richard H. Valentine, '33,* as Director of Research and Development, New Departure Division, General Motors Corporation;

Paul W. Vogel, '38, as Comptroller, Underwood Corporation . . . *George C. Halstead, '40,* as a Vice-president, Alcoa Steamship Company . . . *R. Dixon*

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Speas, '40, as a Vice-president, the Wings Club of New York;

Herbert C. Wohlers, '40, as Director of Research, Solvay Process Division, Allied Chemical Corporation . . . *Will B. Rodemann, '44*, as President, Swiftwater Industries, Inc., Chagrin Falls, Ohio . . . *Harold Brown, '47*, as Vice-president, Walworth Company;

Mrs. Cecily C. Selby, '50, as Headmistress, the Lenox School, New York City . . . *Martin H. Miller, '51*, as Vice-president, Adam Hat Manufacturers, Inc., a division of Miller Brothers Hat Company, Inc.

■ Special honors and awards announced recently include:

To *Luis de Florez, '11*, the Distinguished Flying Cross, from the Secretary of the Navy . . . to *Jerome C. Hunsaker, '12*, Honorary Fellowship, by the Institute of the Aeronautical Sciences . . . to *Philip L. Alger, '15*, the Lamme Medal for 1958, by the American Institute of Electrical Engineers;

To *Crawford H. Greenewalt, '22*, Gold Medal, by the American Institute of Chemists . . . to *William H. Mueser, '22*, the Metropolitan Civil Engineer of the Year Award for 1958, by the Metropolitan Section, American Society of Civil Engineers . . . to *Charles S. Draper, '26*, the Godfrey L. Cabot Award, by the Aero Club of New England;

To *Jacob J. Jaeger, '34*, its 1959 Engineering Citation, by the American Society of Tool Engineers . . . to *Henry R. Wilsey, '36*, the Silver Beaver, by the Eagle Rock (N. J.) Council, Boy Scouts of America;

To *Commander Michael U. Moore, '49*, U. S. Navy, the Air Force Commendation Medal, by the United States Air Force . . . to *Murray Gell-Mann, '51*, the $2,500 Dannie Heineman Prize for mathematical physics, by the American Physical Society and the American Institute of Physics.

How to See M.I.T.

■ Perhaps the best way to get a quick, comprehensive look at M.I.T. these days is to take one of the general tours offered by the Guide Service. They start from the Admissions Office daily at 10:00 A.M. and 2:00 P.M., and cover such points of interest as an electrical engineering laboratory, a chemistry laboratory, the 704 computer, the Hayden Memorial Library, Kresge Auditorium, and the Chapel.

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(*Continued on page 428*)

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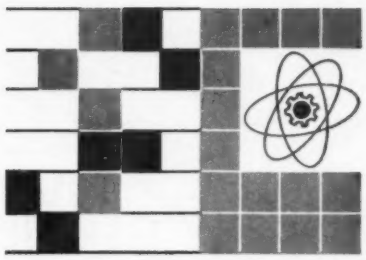

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TREND OF AFFAIRS

(*Continued from page 427*)

The Sloan Men Return

■ A convocation for Sloan Fellows, and another for Senior Executives, who have studied at M.I.T., brought about 200 of them back to Cambridge this spring to hear more about management in an era of dynamic technology. "New developments in business and technology occur so rapidly," said E. P. Brooks, '17, Dean of the School of Industrial Management, "that these men find it of immense help to return to M.I.T."

There have been 333 participants in the Sloan Fellowship Program which began in 1931, and 131 in the program for Senior Executives which began in 1956.

"The management of American enterprise," Alfred P. Sloan, Jr., '95, said at the Sloan Fellows' reunion dinner, "is recognizing, in an accelerating degree and in its own self-interest, the demand for a truly scientific approach to the problems of industrial management."

Next fall, a Sloan Teaching Internship program, to prepare men for teaching and research in industrial management, will begin. The first interns will be: Rhea H. West, Jr., Professor of Management at the University of Arkansas; Louis F. Bucklin, a Northwestern University graduate student; and Charles L. Campbell, 3d, Associate Professor of Economics at Hillsdale College in Hillsdale, Mich.

(*Concluded on page 430*)

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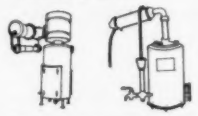

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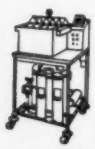

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TREND OF AFFAIRS

(*Concluded from page 428*)

Tuition Will Go Up

■ The tuition fee at M.I.T. will be increased from $1,300 per academic year to $1,500 when the 1960 Summer Session opens. The increase has been necessitated by rising costs and was decided on reluctantly. To help alleviate the burden on parents and students, an Installment Plan has been set up.

This plan will permit the tuition fee to be met by an initial payment of $1,000, either on a term or monthly budget basis during the year, and long-term installment payments on the remainder. The annual interest rate on the unpaid installment balance will be 5 per cent, and no collateral will be required. M.I.T. will use the facilities of the First National Bank of Boston to provide this financial help but will underwrite all installments and bear all handling and collection costs to keep the interest rate as low as possible.

The Institute will continue to help its neediest students from other resources, as in the past, and hopes to expand its traditional sources of financial aid in order to moderate the impact of the tuition increase as much as possible for those who have limited financial means.

Appointments to the Faculty

■ The Faculty of M.I.T. was notified this year of the appointments of four new professors:

Donald G. Marquis, internationally known psychologist, will join the School of Industrial Management. A former chairman of the Department of Psychology at Yale and at the University of Michigan, he comes to the Institute from the staff of the Social Science Research Council in New York. He served under Vannevar Bush, '16 (now honorary chairman of the M.I.T. Corporation), in the Office of Scientific Research and Development during World War II, has been a consultant to many organizations, and is a past president of the American Psychological Association.

Salvador E. Luria, an outstanding authority on bacterial viruses, microbial genetics, and biological effects of radiation, will remain in the Department of Biology where he has been a visiting professor. Dr. Luria has worked in several of the leading research laboratories in this country and Europe, and has taught at the University of Indiana and the University of Illinois.

Richard D. Schafer, Professor and Head of the Department of Mathematics at the University of Connecticut, will join the Department of Mathematics. Educated at the University of Buffalo and the University of Chicago, he has been a member of the Institute for Advanced Study and the faculties of the University of Michigan and the University of Pennsylvania.

Gerald B. Whitham, Associate Professor in the Institute of Mathematical Sciences at New York University, also will join the Department of Mathematics. A native of England, he was educated at Manchester University, where he later served as a lecturer in mathematics.

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NEW LANGUAGE LABORATORY

(*Concluded from page 404*)

languauge laboratory system, called "The Linguatrainer," has been installed. The equipment was manufactured by a local firm, and this installation, which was made possible by a gift from a generous Alumnus, is the first of its kind. It will serve as a pilot model in tests and further research.

The language laboratory now has 14 student positions and plans have been made to increase the number to 30. At each position there is a headset consisting of earphones with a small microphone attached, a volume-control knob and a record-listen switch. All recording and playback equipment is in a metal cabinet in another room.

When a student comes into the laboratory for practice, he tells the instructor in charge which tape he would like to hear and is assigned to a booth. There he puts on the headset, adjusts the position of the microphone, and pushes his switch to "record." He then hears a master recording of the lesson he is to practice. As he listens, the master recording is copied on the individual tape for his position. After each phrase or sentence there is a pause during which the student can repeat what he has just heard. This imitation is also recorded on the student's tape.

When he has heard the entire master tape, the student pushes the switch to "listen." Then he hears the copy of the master tape with his responses. As he compares his pronunciation with that of the speaker on the master tape, he becomes aware of differences that otherwise he would not have noticed.

At the teacher's position at the front of the room, there is a control panel with 14 squares, each of which corresponds to a student booth. Pilot lights in these squares tell the instructor which students are listening to the master tape and which ones are listening to playbacks of their own recording. If the instructor wishes to monitor a student's performance, he may do so. He can also speak to the student individually and make necessary corrections.

There is also an intercom system which enables the instructor to speak to the entire class.

The tapes used are endless loops, so no rewinding is needed. This is important, for most damage to tapes occurs during rewinding. The tapes are stored in plastic cartridges, so no threading is necessary. An automatic device can be used to stop each tape at the completion of the loop.

The recording and playback equipment consists of 14 dual-track tape recorders – one for each student position. Four of these are used as playback machines for master channels. Any student can be tuned in on one of these master channels, make a recording of his own voice on the second track of the tape in the slot corresponding to his booth, then listen to himself.

Each of the 14 students using the laboratory may work on a different problem. Hence, students may practice at their own speed, and students from different classes can use the laboratory simultaneously.

In addition to providing the means for students to develop greater fluency and more accurate pronunciation, the laboratory is being used to study the effect of frequency response of language-laboratory equipment on language learning. The aim of this research, supported by funds granted by Educational Facilities Laboratories (a Ford Foundation agency), is the determination of the optimum frequency response for similar equipment. If high fidelity in playback and recording equipment is important in language learning, money spent on low-fidelity equipment will be wasted. On the other hand, if high fidelity is not important, the cost of equipment for language laboratories may be substantially reduced. There is also the possibility that high-fidelity equipment is necessary for recordings in one language but not in another, so that the specifications of the equipment for a laboratory may be determined by the languages to be taught.

The laboratory is being used now by American students learning German, French, and Russian, and by foreign students who are trying to improve their spoken English. As use of the laboratory increases, it is planned to build a library of recorded exercises, not only for the languages taught at M.I.T. but also for other languages, so that students who wish to learn spoken Arabic, or even Chinese, may do so.

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HISTORY OF FLIGHT

(Concluded from page 416)

miles per hour, or so) is used and then replaced, when once up in the air, by a suitable change in ducting to the high speed "thrust" flow that we use today over a small cross section for fast aircraft. The wing may well become the crankcase of the engine!

We must, also, think of the seaplane. Propeller clearance from the water limited early seaplanes because the configurations required an awkwardly high engine location, or a deep hull, or bulky pontoons. And all this weighed more than a simple land plane, and had more parasitic drag which meant more of that slow speed deterrent. The jet engine, however, is likely to change this picture very greatly in the next decade.

To begin with, the propeller clearance parameter is done away with. Our aerodynamic forms can now rival the land plane, and in a seaplane, alighting on its hull on the water, weight and complications are saved by elimination of heavy landing gear. But the seaplane would still have to contend with rough water, were it not for the imminent advent of VTOL. This will eliminate the "rough water blues"!

Right under our noses, today, are wrong trends, unrealized, and right trends, unappreciated, because we do not think things through enough.

A breakthrough on lighter radiation shielding is now imminent and this means nuclear power plants. So let us start our thinking on this new type, at once, in terms of wing flow and low noise level.

We are becoming aware that speed is the *raison d'être* of flying, particularly also in air transportation of passengers. Have we learned that the greatest comfort of all to a passenger is the notice that he has arrived? A super-comfortable seat does not balance a tediously slow aircraft.

Our air age has only just started, for in our travels and movements of ourselves and our goods, we are about to obsolete the wheel, just as the wheel-and-axle invention obsoleted the skid and roller some 10,000 years ago.

The Regatta Will Be June 20

The annual Intercollegiate Rowing Association Regatta, formerly known as the Poughkeepsie Regatta, will be June 20 on Onondaga Lake, near Syracuse, N.Y. M.I.T. will be one of 14 schools competing, and tickets may be obtained from the M.I.T. Athletic Department. There will be three races, starting at 3:00 P.M.

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Class Reunions in 1959

1894 June 14. M.I.T. Faculty Club, Sloan Building, 50 Memorial Drive, Cambridge. Dinner – 6:00 P.M. Samuel C. Prescott, Secretary, Room 16–317, M.I.T., Cambridge 39.

1899 June 15–16. University Club, 40 Trinity Place, Boston. William A. Kinsman, President, 348 High Street, Newburyport.

1900 June 16–17. Endicott House, Dedham. Elbert G. Allen, Secretary, 11 Richfield Road, West Newton 65.

1901 June 12–14. Endicott House, Dedham. Robert M. Derby, reunion chairman, Brookside Farm, Williamstown.

1904 June 14. Brae Burn Country Club, Newton. Reunion cochairmen: Carle R. Hayward, Room 35–304, M.I.T., Cambridge 39; Eugene H. Russell, Jr., 82 Devonshire Street, Boston 9.

1907 June 12–14. Oyster Harbors Club, Osterville, Mass. Philip B. Walker, Secretary, 18 Summit Street, Whitinsville.

1908 June 12–14. Melrose Inn, Harwich Port, Mass. H. Leston Carter, Secretary, 14 Roslyn Road, Waban 68.

1909 June 12–14. *50th reunion:* Snow Inn, Harwich Port, Mass. Francis M. Loud, reunion chairman, 351 Commercial Street, Weymouth 88.

1914 June 12–14. The Publick House and Treadway House, Sturbridge, Mass. Charles P. Fiske, reunion chairman, Cold Spring Farm, Bath, Maine.

1916 June 12–14. Chatham Bars Inn, Chatham, Mass. Harold F. Dodge, Secretary, 96 Briarcliff Road, Mountain Lakes, N.J.

1919 June 12–14. Wentworth-by-the-Sea, Portsmouth, N.H. Wilfred O. Langille, reunion chairman, Diehl Manufacturing Company, Finderne, Somerville, N.J.

1924 June 12–14. Oyster Harbors Club, Osterville, Mass. Paul J. Cardinal, reunion chairman, 195 Midland Avenue, Montclair, N.J.

1929 June 12–14. Bald Peak Colony Club, Melvin Village, N.H. Francis M. Mead, reunion chairman, 15 Waterhouse Road, Belmont.

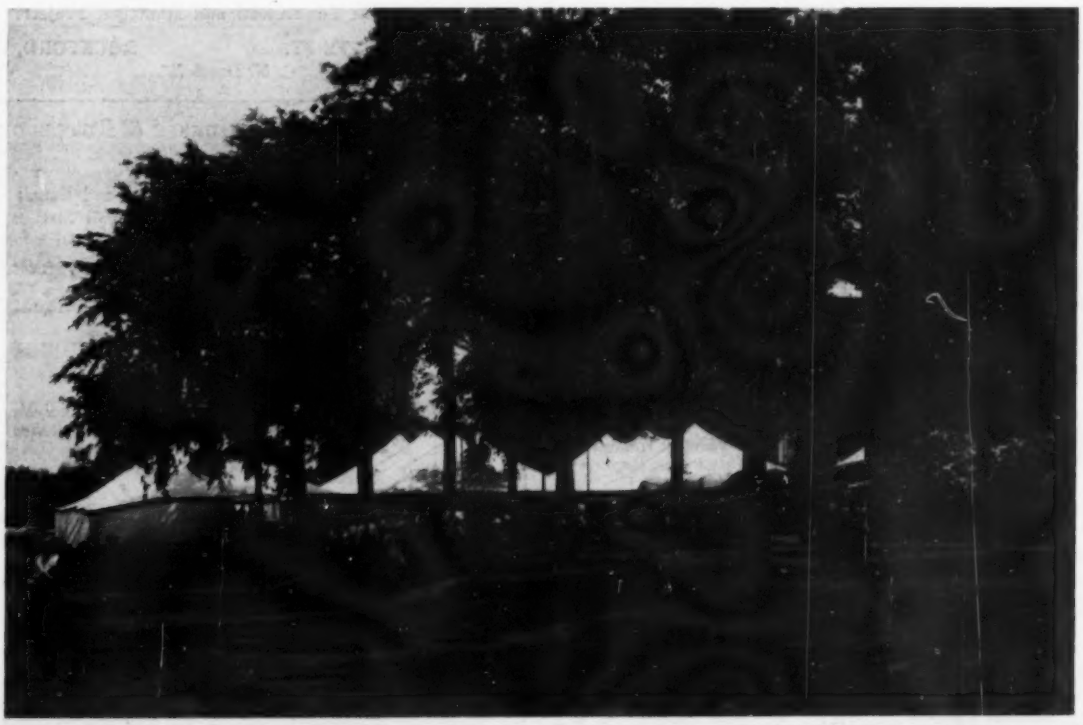
1934 June 12-15. *25th reunion.* Baker House, M.I.T., Cambridge. Malcolm S. Stevens, reunion chairman, Room 1–139, M.I.T.

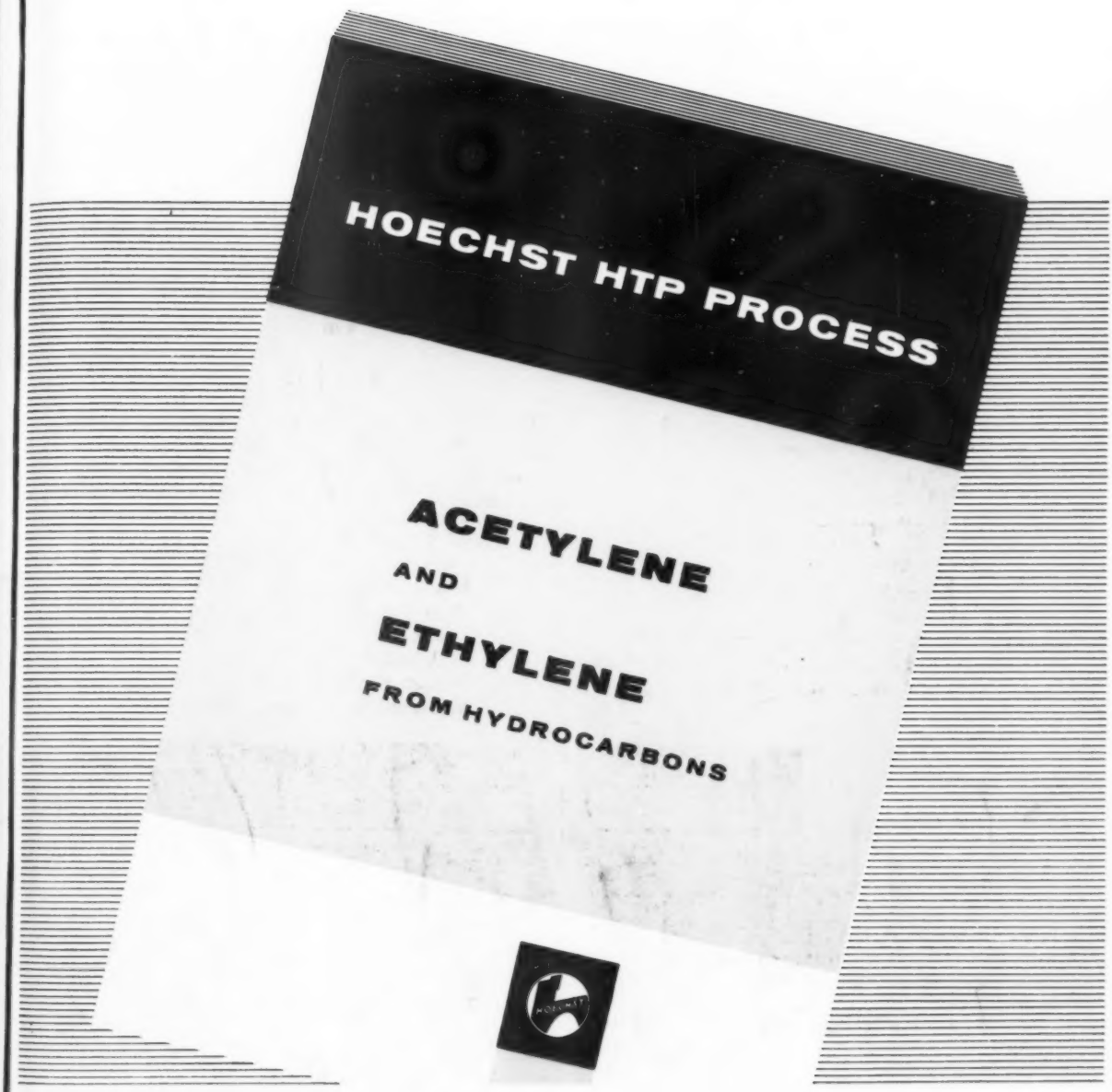
1939 June 12–14. Snow Inn, Harwich Port, Mass. William F. Wingard, reunion chairman, 26 Blithedale Street, Newtonville 60.

1944 June 12–14. Chatham Bars Inn, Chatham, Mass. Reunion cochairmen: (2–44) Burton A. Bromfield, 72 Woodchester Drive, Weston; (10–44) Kenneth G. Scheid, 24 Lee Street, Marblehead.

1949 June 12–14. Hotel Curtis, Lenox, Mass. Reunion cochairmen: Russell N. Cox, 103 Loring Road, Weston 93; Kemon P. Taschioglou, Polaroid Corporation, 730 Main Street, Cambridge 39.

1954 June 13–14. Cliff Hotel, North Scituate, Mass. Robert E. Anslow, reunion chairman, 935 Massachusetts Avenue, Lexington 73.





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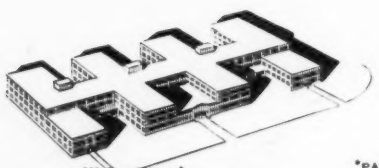

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